THE TELEGRAPHIC JOURNAL AND

# Electrical Review.

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## THE ELECTRIC LIGHT AND RAILWAYS.

IT is gratifying to hear that some advance is being made in the application of the electric light for the illumination of railway passenger trains. There are, we understand, now some seven trains lighted by electricity running on the London, Brighton and South Coast Railway; whilst two trains have recently been fitted, and are now being worked, on the Great Northern. Others are, it is said, in hand for both companies, so that there would appear to be some prospect of, at all events, further and extended trials, the result of which cannot fail, we trust, to promote its ultimate adoption.

That there exists great room for improvement in the lighting of our railway carriages all are agreed. That there also exists a very general opinion that the electric light is that most to be desired for the purpose is equally true; and we feel that we may add to this our opinion that in its proper application those companies which do make use of it will reap a large economy. The cost of oil lighting is known to largely exceed the cost of electric lighting, whilst there exists no possible comparison between the two for lighting purposes.

It is understood that the trains which have been fitted by each of the companies named are being worked upon the Stroudley-Houghton system, that is, that the light is fed by secondary batteries arranged in the guard's van, the batteries being charged by a dynamo, similarly placed, driven from the wheels of the van. Thus the source of the light is in each case located at one point. Experiments in the lighting of railway trains have not, it is true, been very numerous. Still railway companies have not neglected the subject. The London and North-Western, the Great Eastern, the London and South-Western have all had a finger in the pie, yet, strange to say, none have attempted to deal with the subject in a complete and exhaustive manner. In every case the batteries have been arranged together, so that the light throughout the train has been dependent upon its continuity with that point; in fact, the trials have always been confined to trains made up and kept together for the purpose.

We would like to ask, if electricity is to prove our future illuminant for railway carriages, whether it is probable the exigencies of a railway service are likely to be met by any arrangement which does not provide for breaking up the trains without placing the occupants of the carriages so disconnected in darkness. It is clear that the system hitherto pursued makes no provision against this. That it is possible to make such provision we make no question, but that it has not been done is, we believe, the fact. Now if such a system does not, and is not likely to provide for the necessary requirements of the service; and it is clear that railway trains must from time to time throughout their journey be broken up—is it at all probable that those answerable for the safe conduct of the traffic—and by this we mean the safety and comfort of the passengers—will give it that support necessary to secure its adoption? A little light is better than none! and naturally their decision would be in favour of that which may, although in itself not quite satisfactory, be regarded as so far no worse than it has been for some time past.

In dealing with this question it is useless regarding it otherwise than in its entirety. If electricity is to become of service for the purpose of lighting our railway carriages, its application should be thought out in such a manner as will meet the entire demands of the service. Arrangements must be made such as will admit of every vehicle being uncoupled, and again coupled up, with ease and certainty by those whose duty it is to marshal the trains. Each coach must of necessity carry its own lighting power, so that when uncoupled for any purpose, it may have within itself lighting power for a given time. These are requirements which we conceive to be most material to success, and without which we have no hesitation in saying any effort which may be made towards the employment of the light for the purpose named will die out without having effected any solid good.

The question is undoubtedly one of magnitude, and it is its magnitude that renders it so desirable that what is being done should be done with a purpose. The experience already gained has been sufficient to show the excellent adaptability of the light for the work required. It now remains to show how it can be made to practically work in with the requirements of the service. To none are these requirements better known than to the electricians of the several large railway companies, and we feel assured that if they apply their knowledge and experience of the subject they can with ease effect what is desired.

To the several railway companies we would say—If you are about to consider and deal with this matter in a practical manner, remember the "brake" question! Do not forget that at the present day provision has to be made for much interchange of stock. If electric lighting is to be adopted, and we have no doubt of it being so at a future, if not at the present date, whatever is done should be done upon a common basis; so that these interchanges of stock may be effected without inconvenience. Let us consider the result with one company's stock fitted with 15-volt lamps, another with 50-volt, and so forth, one system equipped with one form of coupling and another with something totally different. All this will be clear to our readers, and it is unnecessary for us to touch further upon it. Our conviction that in this application of the light there exists an enormous field for its employment, and that in its employment the railway companies will ultimately effect large economies, will plead as our excuse for having thus plainly dealt with the subject. That its adoption will come we have not the least doubt—whether it is near at hand or not rests in a great measure with the manner in which it is applied by those who have its management in their hands.

THAT the electrical fraternity fully appreciate the social advantages attached to the membership of the Electro-Harmonic Society was, we think, apparent at the gathering at St. James's Hall, on Friday last. It was a pleasant sight to see more than 200 gentlemen, many of whom have attained to the highest eminence in their profession, enjoying a cheery chat with their friends and acquaintances during the intervals in the performances. This Society, at all events, does not trench upon the province of any other, and here alone can members enjoy that freedom from all restraint which makes these meetings so enjoyable. Its advantages are further enhanced by the fact that in it there exists no *clique* of any kind, a merit which its supporters will not be slow to recognise, and by the further circumstance that workers in all branches of electrical science are now eligible for election. From a musical standpoint, also, there is every reason to believe that it will shortly vie with the very best societies in the Metropolis, and this is saying much.

DURING the controversy which has been carried on in several technical papers, including the REVIEW, touching the desirability of, or the objections against, forming a new Electrical Society, the American Electric Light Association has been mentioned as a model upon which to base the field of action which the projected Institute should call its own. When comparing the American Association with the societies which have for some years existed here, it has evidently been forgotten that the gathering of Transatlantic electricians for the reading of practical papers and for the discussions following them, was probably brought about by the fact that there did not exist a society in the States like that of our Telegraph Engineers and Electricians. The American Institute of Electrical Engineers has sprung into being since the summer meetings of the Electric Light Association were inaugurated; had it been otherwise, it is more than probable that the last mentioned would have had no cause for existence.

PROMISES lavishly thrown out in prospectuses, we know, are little regarded by those who make them after the object of the prospectuses has been obtained, after the public have been induced, that is to say, to subscribe the capital for which it has been asked. But rarely is it so soon admitted that the promises were merely so many baits as in the case of Woodhouse and Rawson, Limited. Woodhouse and Rawson, Limited, may be one of the most promising companies of the day, may pay eventually even more than the promised ten per cent.; as to that we express no opinion. But we were a great deal surprised to hear the confession of Sir John Stokes that "of course" ten per cent. was promised in the prospectus, but that whether the promise would ever be fulfilled was quite another matter, not even to be considered yet. The "of course!" was given off quite smilingly, as though expressing a generally recognised and commendable view. Recognised it may be amongst those who profit by the credulity of the public; unfortunately it is not yet recognised by the public itself. Few "financiers" are so candid—so soon, at any rate—as Sir John Stokes.

FOR the articles on the Westinghouse system of electric lighting which were published in recent numbers of the REVIEW, we were indebted to the *Electrical Engineer*, of New York. Mr. Addenbrooke in our issue of to-day has made some comments upon the system which will doubtless attract some attention "on the other side."

TO show how easily dust may be thrown into the eyes of the unscientific public, we mention an instance which appeared in the *Times* a few days ago. Mr. Walsh, who is interested in the "Eclipse" primary battery, states that this battery only takes three minutes to charge, whereas the Swan accumulator takes three hours, to insure a good light for the following day. Now Mr. Walsh must know as well as we do, that accumulators are not connected up singly, and that 100 may be charged at the same time as easily as one. With 100 cells placed in circuit for three hours, this would represent a period of less than two minutes per cell. Naturally it is necessary to have a charging plant, but here, again, Mr. Walsh is perfectly aware that electrical energy can be produced by means of a dynamo and steam engine at the pit's mouth many times cheaper than by means of his much vaunted "Eclipse" battery, which we had hoped had ere this disappeared from this mundane sphere.

IT appears that there are at least half-a-dozen projects now on foot for the supply of electric lighting by transformers from central stations. In one gigantic scheme we hear of a projected dynamo with an armature 42 feet (!) in diameter, which is to give 10,000 volts and pass a current along the line of 300 ampères.

MR. WALSH intends to claim the premium of £500 offered by Mr. Ellis Lever for a satisfactory miners' lamp on behalf of the "Eclipse" battery and lamp, because "the Eclipse safety lamp is a primary battery," because "it can be charged by any unskilled hand within three minutes," and because "the cost of the Swan miners' lamp is nearly 200 per cent. more than the cost of the Eclipse battery." Some other reasons he gives, one being that the cost with the Eclipse of maintaining a $2\frac{1}{2}$ candle light for 12 hours is only 1d., and another that the Swan apparatus weighs $7\frac{3}{4}$ lbs., as against Eclipse 5 lbs.; but we are afraid the gentlemen to whom Mr. Lever has entrusted the task of judging the merits of lamps submitted will scarcely think any of them conclusive as to the superiority of the Eclipse over other systems, or as to its fitness to be termed a satisfactory miners' lamp such as is contemplated in the conditions laid down by Mr. Lever.

MR. J. RICHARDS KELLY, M.P., is anxious to see an exhibition of portable electric lamps, and he suggests that the most appropriate place for such an exhibition is the Royal School of Mines. We are fully persuaded that if Mr. Kelly's idea were carried into effect, a great deal of good would be effected. Colliery owners and persons interested in mines would then have the opportunity of inspecting and comparing the existing forms of electric safety lamps, many of which have undoubted merits; indeed, Mr. Kelly says proprietors and managers would be "forced to give far more consideration to the question than they would appear at all ready now to bestow upon it."

MESSRS. IMMISCH & CO. are making great progress with their motors. From the article which we publish in another part of the REVIEW it appears that they have practically approached close to the limits of theoretical efficiency. Mr. Immisch deserves his success, for he has worked hard for several years without faltering, the result being that the crude apparatus first constructed by him has now been so perfected that little more seems necessary to be done, except perhaps in the way of mechanical improvements and reduction of cost of manufacture.

## PATERSON & COOPER'S NEW DYNAMOS.

WE illustrate below two of the latest type of "Phœnix" dynamo constructed by Messrs. Paterson & Cooper. We intimated some time ago that single magnet machines were being made by this firm in which the horse-shoe magnet consisted of a single wrought iron forging slotted out in the middle to form the two limbs and bored out to form the polar extensions, the absence of joints in the magnetic circuit being the chief advantage of this design. One of these machines is shown in fig. 1, the armature being supported by two gun-metal bridge brackets bolted to the magnet. Two cast iron angle pieces bolted to the yoke take the place of a bed-plate, these being provided with the necessary holes for foundation bolts. It is evident that by this construction a machine is obtained which gives for its weight a large output, and the design is therefore recommended in cases where the reduction of weight is a matter for consideration. But in the majority of instances in which dynamos are employed, and in all stationary positions, weight is only of secondary importance, and, provided efficiency is not sacrificed, any modification in construction which will enable machines to be produced at less cost may be considered

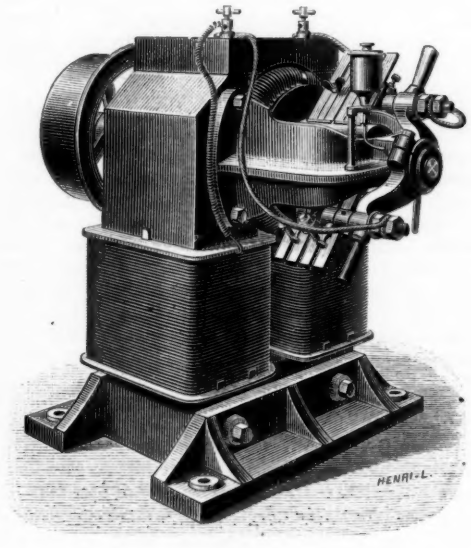


FIG. 1.

a step in the right direction, even if they are heavier for their output than formerly. Messrs. Paterson & Cooper have recognised this in introducing the alternative design of their single magnet type shown in fig. 2. From the amount of tooling required in the first machine it necessarily costs more to manufacture than the second one. Here the magnet is of carefully selected cast iron, the two limbs and the bed-plate being cast in one piece, and the magnetic circuit, as in the former machine, without joint. The armature is supported by two strong cast iron standards bolted to the bed-plate, the bearings being of white metal. The magnet coils are wound on separate bobbins of sheet iron flanged with brass, which are, after being wound, slipped over the tops of their respective limbs into place. The collector is of hard drawn copper insulated with mica, and a special feature lies in the construction of the brush gear by which a forward thrust is given to the brush in a direction parallel to itself. Where the brush holder is movable round a pin, as is usually the case, the angle at which the brush lies relatively to the collector alters as the former wears, the result being that, in order to bed fairly on the collector, the brushes have to be filed up each time they are pushed forward. However slowly the brushes wear, it is an advantage to be able to dispense with this filing, and in the new machine the brush holders slide on rods lying parallel to the brush, the latter being held up to the collector by helical springs which permit of the pressure being varied if necessary while running. The brushes always occupy the same position relatively to the collector and require no filing from the day they are first put in the holder till they are completely worn out. The engraving unfortunately does not show this brush gear as it was designed after the block was cut.

The machines are made in twelve sizes, the output ranging from 600 to 30,000 watts and the speed from 1,800 to 700 revolutions per minute. The block for fig. 2 has been cut from a photograph of the No. 7 size which, at a speed of 1,360 revs., gives 60 ampères at 100 volts, or 6,000 watts.

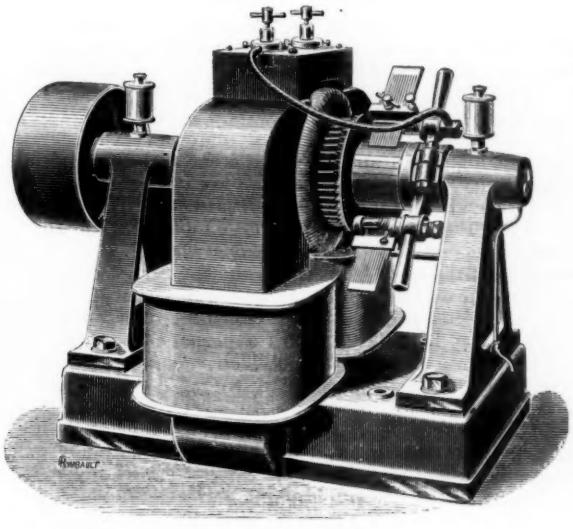


FIG. 2

## MODERN VIEWS OF ELECTRICITY.*

By PROF. OLIVER J. LODGE, in *Nature*.

PART II.—III.

WE have now glanced through electro-static phenomena, and seen that they could be all comprehended and partially explained by supposing electricity to be a fluid of perfect incompressibility—in other words, a liquid—permeating everywhere and everything; and by further supposing that in conducting matter this liquid was capable of free locomotion, but that in insulators and general space it was as it were entangled in some elastic medium or jelly, to strains in which electro-static actions are due. This medium might be burst, in a disruptive discharge, but easy flow could go on only through channels or holes in it, which therefore were taken to represent conductors; and it was obvious that all flow must take place in closed circuits.

To day I want to consider the circumstances of this flow more particularly: to study, in fact, the second division of our subject (see classification on page 407) viz., *electricity in locomotion*.

I use the term "locomotion" in order to eliminate rotation and vibration: it is translation only with which we intend now to concern ourselves.

Consider the modes in which *water* may be made to move from place to place; there are only two; it may be pumped along pipes, or it may be carried about in jugs. In other words, it may travel *through* matter, or it may travel *with* matter. Just so it is with *heat* also:

* Expansion of a lecture delivered by Dr. Oliver Lodge, partly at the London Institution on January 1st, 1885, and partly at the Midland Institute, Birmingham, November 15th, 1886, but not hitherto published.

heat can travel in two ways: it can flow *through* matter, by what is called "conduction," and it can travel *with* matter, by what is called "convection." There is no other mode of conveyance of heat. You frequently find it stated that there is a third method, viz., "radiation"; but this is not truly a conveyance of *heat* at all. Heat generates radiation at one place, and radiation reproduces heat at another; but it is radiation which travels, and not heat. Heat only naturally flows from hot bodies to cold, just as water only naturally flows down hill; but radiation spreads in all directions, without the least attention to where it is going. Heat can only flow one way at any given point, but radiation travels all ways at once. If water were dissociated on one planet into its constituent gases, and if these recombined on another planet, it would not be water which travelled from one to the other, neither would the substance obey the laws of motion of water—water would be destroyed in one place, and reproduced in another; just so is it with the relation between radiation and heat.

Heat, then, like water, has but two direct modes of conveyance from place to place. For *electricity* the same is true. Electricity can travel with matter, or it can travel through matter; by convection or by conduction, but in no other known way.

*Conduction in Metals.*

Consider, first, conduction. Connect the poles of a voltaic battery to the two ends of a copper wire, and think of what we call "the current." It is a true flow of electricity among the molecules of the wire. If electricity were a fluid, then it would be a transport of that fluid; if electricity is nothing material, then a current is no material transfer; but it is certainly a transfer of electricity, whatever electricity may be. Permitting ourselves again the analogy of a liquid, we can picture it flowing through, or among, the molecules of the metal. Does it flow through or between them? Or does it get handed on from one to the next continually? We do not quite know; but the last supposition is often believed to most nearly represent the probable truth. The flow may be thought of as a perpetual attempt to set up a strain like that in a dielectric, combined with an equally perpetual breaking down of every trace of that strain. If the atoms be conceived as little conductors vibrating about and knocking each other, so as to be easily and completely able to pass on any electric charge they may possess, then, through a medium so constituted, electric conduction could go on much as it does go on in a metal. Each atom would receive a charge from those behind it, and hand it on to those in front of it, and thus may electricity get conveyed along the wire. Do not, however, accept this picture as anything better than a *possible* mode of reducing conduction to a kind of electrostatics—an interchange of electric charges among a series of conductors. If such a series of vibrating and colliding particles existed, then certainly a charge given to any point would rapidly distribute itself over the whole, and the potential would quickly become uniform; but it by no means follows that the actual process of conduction is anything like this. Certainly it is not the simplest mode of picturing it for ordinary purposes. The easiest and crudest idea is to liken a wire conveying electricity to a pipe full of marbles or sand conveying water; and for many purposes, though not for all, this crude idea suffices.

Leaving the actual mode of conveyance as unknown, let us review how much is certainly known of the process called conduction.

This much is certainly known:—

(1). That the wire gets heated by the passage of a current.

(2). That no trace of a tendency to reverse discharge or spring back exists.

(3). That the electricity meets with a certain amount of resistance or friction like obstruction.

(4). That this force of obstruction is accurately proportional to the speed with which the electricity travels through the metal—that is, to the intensity of the current per unit area.

About this last fact a word or two must be said. The amount of electricity conveyed per second across a unit area is called the intensity of current; and experiment proves, what Ohm originally guessed as probable from the analogy of heat conduction, that this intensity is accurately proportional to the slope of potential which causes the flow; or, in other words (since action and reaction are equal and opposite), that a current in a conductor meets with an obstructive electromotive force exactly proportional to itself. The particular ratio between the two depends upon the particular material of which the conductor is composed, and is one of the constants of the material, to be determined by direct measurement. It is called its "specific conductivity" or its "specific resistance" according to the way it is regarded. The law here stated is called Ohm's law, and is one of the most accurately-known laws there are. Nevertheless it is an empirical relation; in other words, it has not yet been accounted for—it must be accepted as an experimental fact. Undoubtedly, it is one of vast and far-reaching importance: it asserts a connection between electricity and ordinary matter of a definite and simple kind.

Now if we think of this opposing electromotive force as analogous to friction, it is very easy to think of heat being generated by the passage of a current, and to suppose that the rate of heat-production will be directly proportional to the opposing force and to the current driven against it—as in fact Joule experimentally proved it to be.

But if we are not satisfied with this vague analogy, and wish to penetrate into the ultimate nature of heat and the mode in which it can be generated, then we can return to the consideration of a multitude of oscillating and colliding particles moving with a certain average energy which determines what we call the temperature of the body. If now one or more of these bodies receives a knock, the energy of the blow is speedily shared among all the others, and they all begin to move rather more energetically than before; the body which the assemblage of particles constitutes is said to have risen in temperature. This illustrates the production of heat by a blow or other mechanical means. But now, instead of *striking* one of the balls, give it an electric charge; or, better still, put within its reach a constant reservoir of electricity from which it can receive a charge every time it strikes it, and at the same time put within the reach of some other of the assemblage of particles another reservoir of infinite capacity which shall be able to drain away all the electricity it may receive. In practice there is no need of infinite reservoirs; all that is wanted is to connect two finite reservoirs, or "electrodes," as one might now call them, with some constant means of propelling electricity from one to the other, *i.e.*, with the poles of a voltaic battery or a Holtz machine.

What will be the result of thus passing a series of electric charges through the assemblage of particles? Plainly the act of receiving a charge and passing it on will tend to increase the original motion of each particle; it will tend to raise the temperature of the body. In this way, therefore, it is possible to picture the mode in which an electric current generates heat.

But although this process may be used as a possible analogy, it cannot be a true and complete statement of what occurs; for it is essentially the mode of propagation of *sound*. Sound travels at a definite and known velocity, being a mechanical disturbance handed on from particle to particle in the manner described. But heat, being some mode of motion, must also be handed on after some analogous fashion, so that when heat is supplied to one point of a mass it spreads or diffuses through it. It is difficult to suppose the conduction of heat to be other than the handing on of molecular quiverings from one to another, and yet it takes place according to laws altogether different from those of the propagation of the gross disturbance called sound. The exact mode of conduction of heat is unknown, but, whatever it is, it can hardly be doubted that the conduction of electricity through metals is not very unlike

it, for the two processes obey the same laws of propagation: they are both of the nature of a diffusion, they both obey Ohm's law, and a metal which conducts heat well conducts electricity well also.

*Conduction in Liquids.*

Leaving the obscure subject of conduction in metals for the present, let us pass to the consideration of the way in which electricity flows through liquids. By "liquids," in the present connection, one more particularly means definite chemical compounds, such as acids, alkalies, salt and water, and saline solutions generally. Some liquids there are, like alcohol, turpentine, bisulphide of carbon, and possibly water, which, when quite pure, either wholly or very nearly decline to conduct electricity at all. Such liquids as these may be classed along with air and gases as more or less perfect dielectrics. Other liquids there are, like mercury and molten metals generally, which conduct after precisely the same fashion as they do when solid. These, therefore, are properly classed among metallic conductors.

But most chemical compounds, when liquefied either by heat or by solution, conduct in a way peculiarly their own; and these are called "electrolytes."

The present state of our knowledge enables us to make the following assertions with considerable confidence of their truth:—

(1). Electrolytic conduction is invariably accompanied by chemical decomposition, and in fact only occurs by means of it.

(2). The electricity does not flow *through*, but *with*, the atoms of matter, which travel along and convey their charges something after the manner of pith balls.

(3). The electric charge belonging to each atom of matter is a simple multiple of a definite quantity of electricity, which quantity is an absolute constant quite independent of the nature of the particular substance to which the atoms belong.

(4). Positive electricity is conveyed through a liquid by something equivalent to a procession of the electro-positive atoms of the compound in the direction called the direction of the current; and at the same time negative electricity is conveyed in the opposite direction by a similar procession of the electro-negative atoms.

(5). On any atom reaching an electrode it may be forced to get rid of its electric charge, and, combining with others of the same kind, escape in the free state: in which case visible decomposition results. Or it may find something else handy with which to combine—say on the electrode or in the solution; and in that case the decomposition, though real, is masked, and not apparent.

(6). But, on the other hand, the atom may cling to its electric charge with such tenacity as to stop the current: the opposition force exerted by these atoms upon the current being called polarisation.

(7). No such opposition force, or tending to spring back, is experienced in the interior of a mass of fluid: it occurs only at the electrodes.

It would take too long to go into the evidence for these statements and to adduce examples: I will try and make the process of electrolytic conduction clearer by reverting to our mechanical analogies and models.

Looking back to figs. 5 and 6 (p. 431), we see illustrations of metallic conduction and of dielectric induction. In each case an applied electromotive force causes some movement of electricity; but, whereas in the first case it is a continuous almost unresisted movement or steady flow through or among the atoms of matter, in the second case it is a momentary shift or displacement only, carrying the atoms of matter with it, and highly resisted in consequence—resisted, not with a mere frictional rub which retards but does not check the motion, but by an active spring back force, which immediately checks all further current, produces what we call "insulation," and ultimately, when the propelling force is removed, causes a quick reverse motion or discharge. But the model is plainly an incomplete one: for what is it that the atoms are clinging to? What is it ought to take the place of the *beam* in the crude mechanical contrivance? Obviously another set of atoms, which are either kept still or urged in the opposite direction by a simultaneous opposite displacement of negative electricity. We are to picture two or any number of rows of beads, each row threaded on its appropriate cord; the cords alternately representing positive and negative electricity respectively, and being simultaneously displaced in opposite directions by any applied E.M.F. The beads threaded on any one cord have, in a dielectric, elastic attachments to those on some opposite cord, and thus continuous motion of the cords in opposite directions is prevented: only a slight displacement is permitted, followed by a spring back and oscillation after the fashion already described.

Very well; now picture the elastic connections between the beads all dissolved, and once more apply a force to each cord, moving half of them one way and the alternate half the other way, and you have a model illustrating an electrolyte and electrolytic conduction. The atoms are no longer attached to each other, but they are attached to the cord. In the first respect, an electrolyte differs from a dielectric; in the second, it differs from a metal.

Moreover, electrolytic conduction is perceived to be scarcely of the nature of true conduction: the electricity does not slip through or among the molecules, it goes with them. The constituents of each molecule are free of each other, and while one set of atoms conveys positive electricity, the other set carries negative electricity in the opposite direction; and so it is by a procession of free atoms that the current is transmitted. The process is of the nature of convection; the atoms act as carriers. Free locomotion of charged atoms is essential to electrolysis.

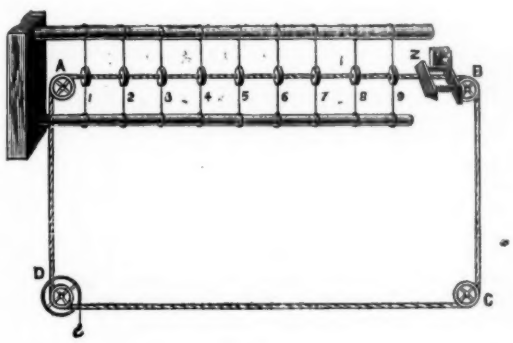



FIG. 13.

Crude mechanical analogy, illustrating a few points in a circuit partly *electrolytic*.

In order to compare with figs. 5 and 6, so as to bring out the points of difference, fig. 13 is drawn. The beads representing one set of atoms of matter are tightly attached to the cord, no trace of slip between them being permitted, but otherwise they are free, and so are represented as supported merely by rings sliding freely on glass rods. The only resistance to the motion, beside the slight friction, is offered at the electrode, which is typified by the spring-backed knife-edge, Z. This is supposed to be able to release the beads from the cord when they are pressed against it with sufficient force. The cling between the bead and cord (*i.e.*, between each atom and its charge) is great enough to cause a perceptible compression of the springs, and accordingly to bring out a recoil force in imitation of polarisation.

The piece of cord accompanying each bead on its journey (*i.e.*, the length between it and the next bead) represents the atomic charge, and is a perfectly constant quantity: the only variation permissible in it is that some kinds of atoms have twice as much, or are twice as far apart on their cord, and these are called by chemists dyad atoms; another kind has three times

as much, another four, and so on; these being called triad, tetrad, &c.

If the cord be taken to represent positive electricity, the beads on it may represent atoms of hydrogen, or other monad *cation*, travelling down stream to the cathode. Another cord representing negative electricity may be ranged alongside it, with its beads twice as far apart, to represent the atoms of a dyad *anion*, like oxygen. If the cords are so mechanically connected that they must move with equal pace in opposite directions, we have a model illustrating several important facts. The number of oxygen atoms liberated in a given time will be obviously half the number of hydrogen atoms set free in the same time, and will therefore in the gaseous state occupy but half the volume. For any element whatever, the number of atoms liberated in any time is equal to the number of atoms of hydrogen liberated in the same time, divided by the "valency" of the element as compared with hydrogen. This law was discovered by Faraday, and appears to be precisely true; and inasmuch as the relative weight of every element is known with fair accuracy, it is easy to calculate what weight of substance any given current will deposit or set free in an hour, if we once determine it experimentally for any one substance.

We may summarise thus:—

If we apply E.M.F. to a metal we get a continuous flow, and the result is heat.

If we apply it to a dielectric we get a momentary flow or displacement, and the result is the potential energy of "charge."

If we apply it to an electrolyte we again get a continuous flow, and the result is chemical decomposition.

There are a large number of important points to which I might direct your attention in the mode by which an electric current is conveyed through liquids, but I will specially select one, viz., that it is effected by a procession of positively charged atoms travelling one way, and a corresponding procession of negatively charged atoms the other way.

Whatever we understand by a positive charge and a negative charge, it is certain that the atoms of, say a water molecule, are charged, the hydrogen positively, the oxygen negatively; and it is almost certain that they hang together by reason of the attraction between their opposite charges. It is also certain that when an electromotive force—*i.e.*, any force capable of propelling electricity—is brought to bear on the liquid, the hydrogen atoms travel on the whole in one direction, viz., down hill, and the oxygen atoms travel in the other direction, viz., up hill; using the idea of level as our analogue for electric potential in this case. The atoms may be said to be driven along by their electric charges just as charged pith balls would be driven along; and they thus act as conveyers of electricity, which otherwise would be unable to move through the liquid.

Each of this pair of opposite processions goes on until it meets with some discontinuity—either some change of liquid, or some solid conductor. At a change of liquid another set of atoms continues the convection, and nothing very particular need be noticed at the junction; but at a solid conductor the stream of atoms must stop: you cannot have locomotion of the atoms of a solid. The obstruction so produced may stop the procession, and therefore the current, altogether; or, on the other hand, the force driving the charges forward may be so great as to wrench them free, to give the charges up to the electrode which conveys it away by common conduction, and to crowd the atoms together in such a way that they are glad to combine with each other and escape.

Now notice the fact of the two opposite processions. One cannot have a procession of positive atoms through a liquid without a corresponding procession of negative ones. In other words, an electric current in a liquid necessarily consists of a flow of positive electricity in one direction, combined with a flow of negative electricity in the opposite direction. And if this is thus proved to occur in a liquid, why should it not occur everywhere? It is at least well to bear the possibility in mind.

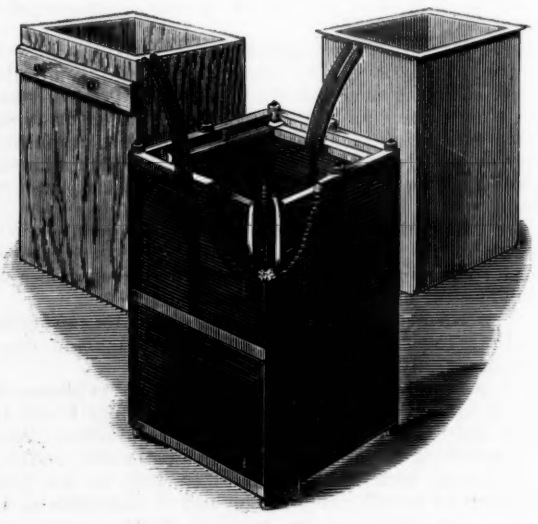
Another case is known where an electric current certainly consists of two opposite streams of electricity, viz., the case of the Holtz machine. While the machine is being turned, with its terminals somehow connected, the glass plate acts as a carrier conveying a charge from one collecting comb to the other at every half revolution; but, whereas it carries positive electricity for one half a rotation, it carries negative for the other half. The top of the Holtz disc is always, say, positively charged, and is travelling forward, while the bottom half, which is travelling backward at an equal rate, is negatively charged.

In the Holtz case the speeds are necessarily equal, but the charges are not. In the electrolytic case the charges are necessarily equal, but the speeds are not. Each atom has its own rate of motion in a given liquid, independently of what it may happen to have been combined with. This is a law discovered by Kohlrausch. Hydrogen travels faster than any other kind of atom; and on the sum of the speeds of the two opposite atoms in a compound the conductivity of the liquid depends. Acids therefore in general conduct better than their salts.

(*To be continued.*)

## ELIESON'S NEW SECONDARY BATTERY.

MR. ELIESON'S reasons for designing a new form of accumulator are based upon his recent experiences in tramcar propulsion. He has found that in practical working the present forms of batteries, including his own, on the principle of alternate, positive and negative plates, are not likely to prove successful for any length of time for the purposes of electric locomotion. It appears that the chances of buckling and short circuiting, due to mechanical and electrical action, have



not yet been eliminated, and that the continuous vibration and jolting on the track will distort the best mechanical arrangement in a comparatively short time. Up to the present no one has discovered a more suitable metal than lead, and this, owing to its weight, adds greatly to the distorting influences. Mr. Elieson, therefore, found it absolutely necessary to set to work and design a new form of cell which should secure a maximum of active surface with a minimum of weight, and, at the same time, ensure a durability which does not seem obtainable under the known methods of construction. It will be seen from the drawing which accompanies this description that the battery of Mr.

Elieson consists of but two electrodes, although for special purposes these may be increased. The cast lead frame of each is in the shape of a hollow square about 9 inches deep; the outer one being 6 inches and the inner 4½ inches square. Each side is filled up with longitudinal strips of lead foil separated, except in those points through which the bolts referred to below pass, as in the inventor's previous form of plate, by asbestos paper. The skeleton frame at each corner, and in the centre of each side, is furnished with a tapped bolt, and when the lead foil is all built up a movable top clamp, also of cast lead, is placed over all, and the whole mass tightened up as desired by screw nuts of ebonite.

The two electrodes are placed one inside the other in a leaden box, being insulated from one another by thick India-rubber bands stretched from top to bottom at each corner, and insulated from the bottom of the box by a cross piece of wood; the whole is contained in a teak case.

Mr. Elieson believes that the type of cell which he has submitted to us will fulfil all that is required for the purpose of electrical propulsion, but it is rash to prophecy with regard to the future of cells constructed for this special purpose. The weight of the two elements is 36 lbs., and the surface exposed is estimated at 26,000 square inches. We hope that the inventor's belief that this form of cell marks another forward step in the production of a practically perfect accumulator for tramcars will be realised.

## IMMISCH'S ELECTRO-MOTORS.

MESSRS. IMMISCH & CO. have just completed a very interesting electrical plant for the Spanish Navy. The plant includes two 30 H.P., three 4 H.P., and one ½ H.P. motors. The machines were all built to the specification of the Spanish Naval Commissioners, and were tested in the presence of three of their representatives.

The tests showed that the contractors had fully discharged the conditions of the specification. The annexed tables give the figures obtained from one of the 30 H.P. motors. The H.P. given out was measured by an absorption brake of the Prony type.

The diameter of the pulley was 24 inches and the face 17 inches. The length of the arm of the brake was 63 inches. The brake was balanced so that it was only necessary to read the actual weight on the arm. The formula used was

$$\text{H.P.} = \frac{2\,\pi\,l\,n\,w}{33{,}000}$$

where $l$ = length of brake arm in feet,
$n$ = revs. per minute,
$w$ = weight on arm in lbs.

Putting $l = 63$ inches, we have H.P. $= \cdot 001\ n\ w$, which is a very convenient form for calculation.

| Speed. | Weight in lbs. | Volts. | Amps. | H.P. | E.H.P. | Efficiency. |
|---|---|---|---|---|---|---|
| 660 | 45½ | 500 | 49 | 29·8 | 33 | 90 |
| 680 | 45½ | 500 | 48 | 29·5 | 32·2 | 91 |
| 675 | 45½ | 500 | 49 | 29·5 | 33 | 89 |

The resistance of the armature was ·47 ohms, and that of the field ·355; these resistances were taken down when the machine had acquired the normal temperature for full output. The volts lost over the resistance of the machine were $49 \times \cdot 825 = 40 \cdot 5$ volts. Therefore the theoretical possible efficiency of conversion was

$$\frac{459 \cdot 5}{500} = 92 \text{ per cent., nearly.}$$

The actual efficiency obtained averaged 90 per cent., allowing about 2 per cent. loss for mechanical friction, Foucault currents, &c. This comes within 2 per cent. of the possible efficiency.

The 30 H.P. motors weigh 17 cwt. each.

Each one is fitted with a resistance frame divided into three sections for starting. The reducing and *make* and *break* switches are so arranged that all the resistance must be put into the circuit before *breaking*. Hence it is impossible to start without first running through the resistance.

A large supplementary switch with an extra long *break* is also provided for use in conjunction with the resistance switch, or separately in case of emergency. It is intended to run the motors from accumulators, and provision has been made to couple the cells in single series or two parallels, thus giving full or half speed on the motor shaft. The commutating switch used for this purpose is locked by the reducing switch in such a manner that it is only possible to change the coupling of the cells after the circuit is broken on the reducing switch. This obviates the risk of short circuiting the accumulators. The direction of motion is changed by reversing the current in the armature.

A sufficiently substantial switch is provided for this purpose. The brushes are of the "Immisch" balanced, tangent type. The machines run very smoothly, and are practically sparkless.

## ELECTRIC MOTORS v. STEAM ENGINES.

WRITING to the *Western Electrician*, Mr. C. M. Barclay, of the Sprague Electric Railway and Motor Company, of Chicago, says:—

In an editorial in your issue of October 8th, answering inquiries from correspondents as to the character of electric motors, and the inquiry whether a motor would be cheaper than a steam engine, we are afraid the explanations are not clear enough, and are apt to mislead electricians and electric business men, as well as users of power.

In the first place, on moderately small engines, say of 25 or 30 horse-power, it is found cheaper to use electric power than to generate steam power individually. Witness the large amount of electric power now being distributed in cities and the statement of the users that it is as cheap and, many state, when taking the matter of convenience into consideration, it is decidedly cheaper than steam power.

Again, you say "the power actually utilised may not exceed 40 to 50 per cent. of the power generated," which means that the other 60 or 50 per cent. is taken up in loss in transmission and conversion. This statement is correct if you had qualified it by saying "over long distances or where the source of power costs but little." To illustrate: Assuming 200 horse-power in water and 100 horse-power being required for actual work a number of miles off. In this case it would probably be cheaper to lose 50 per cent. in transmission, but in ordinary cases of distribution in towns, the recovery in actual practice on the pulley of the motor is 65 to 75 per cent.

Further on you say, "hence, it is cheaper to use the power direct from the engine or water wheel when possible, than to transform and transfer by means of electricity." To that statement we beg to take exception. It is not always the most economical to use the power direct from the engine or water wheel, as the following statement will show: An engineer made a test of eight New England cotton mills, and found that the average loss in the eight mills was over 30 per cent. in the lines of shafting alone before the delivery of any power for work, and in one case, where the horse-power required for the whole load was 670, the horse-power used for shafting alone was 262, or 39 per cent. Thus, if electric power was distributed in several units to different parts of the mill, the constant load of shafting would be avoided. The advantages of using the power at or near the work done, which is available by electricity, does away with the constant load, which is enormous when the shafting is of considerable length, or when angles have to be turned, or in groups of buildings from one source of supply. In electrical transmission, the loss is always a fixed per cent. of the total power, whether it be large or small, thus securing a much greater economy where power to be supplied is variable.

You say again, "if the time ever comes when the heat of the furnace can be converted at once into electricity, the engine can then be dispensed with and the motor take its place." In reply to that, we would say that we do not require to wait until then for the motor to take its place, for it is now taking the place of engines in hundreds of cases, with the result that the engines are still used as prime generators of power but in larger units, admitting of a general average in distribution, consequently less cost in production than in a number of units or small engines, where the general average and intermittent use would not come into play.

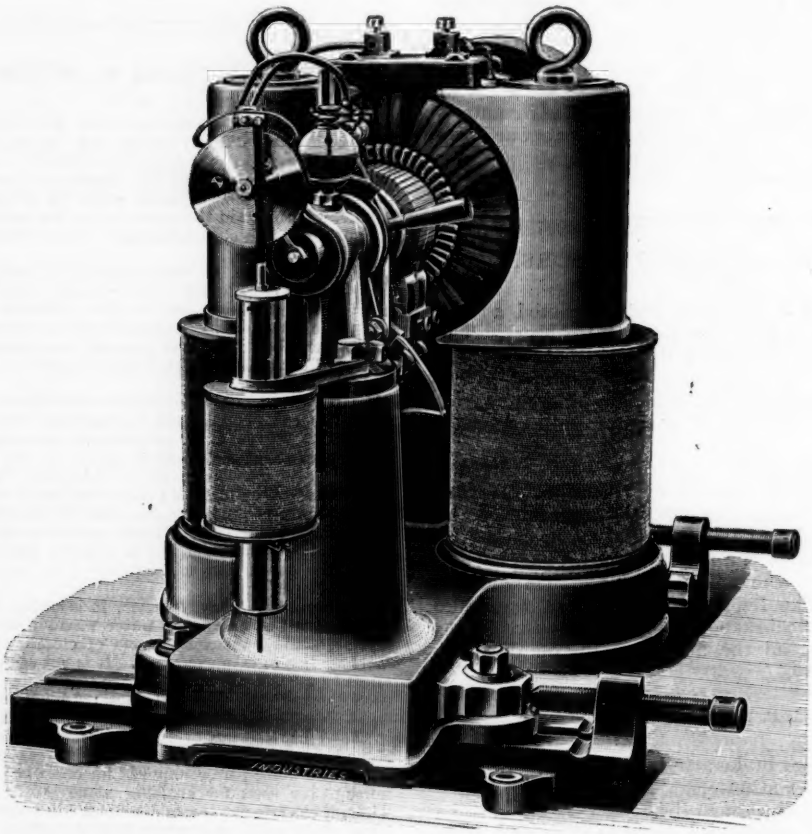
**Consolidated Telephone Construction and Maintenance Company, Limited.**—An order was made last Saturday for the reduction of the capital of this company, the sum of 1s. per share being returned to the shareholders upon shares on which 15s. had been paid.

## MESSRS. J. G. STATTER AND COMPANY'S NEW WORKS.

ONE of the most successful of recently-established electrical businesses is that which was started only a year or two ago by Mr. J. G. Statter and Mr. S. L. Brunton at Dalston. Its rapid development there soon necessitated its removal to larger premises, and a few months since the concern was formed into a limited liability company, which increased the capital and provided for the removal of the works to West Drayton, a locality very easily reached from almost any part of London. The works, which cover an area of about an acre of ground, are provided with every requisite for carrying on a large electrical and general engineering business, and are conveniently situated with regard to both railway and water communication. One building comprises well lighted and commodious erecting and machine shops, with overhead travelling crane and a good supply of the necessary tools, as well as a large upper floor with a splendid light for such work as the construction of instruments and arc lamps. In another erection are well-arranged iron and brass foundries, with two cupolas and range of brass furnaces. Smiths' shops, pattern-makers' shops, stores and offices are all arranged with a view to completeness, and a dock communicating with the Grand Junction Canal gives facilities for the receipt and despatch of heavy goods in every desirable direction at the most economical rates. On the occasion of a recent visit we found a number of interesting operations in progress. In addition to the arc lamps, dynamos, and measuring instruments which were to be seen in various stages of manufacture, a 55 horse-power engine was in course of completion for driving the machinery of the works. We were shown a portable electric lighting set which had been wholly designed and constructed on the premises, consisting of a vertical high-speed engine, vertical boiler, and a 3½ unit dynamo, all on a light iron 4-wheel trolley. with shafts for horse traction. This appeared to be a very neat and useful arrangement for outdoor requirements. On another light trolley was a projector with 2 feet mirror, fitted with a patent method of varying the range covered by the projector, the turning of a hand wheel giving any divergence of the beam of light to 25° or more. This arrangement is suitable for finding any object at a distance before throwing a concentrated beam of light upon it.

The Statter arc lamp has undergone some changes in the details of construction since we described it in these columns, but the principle and main features remain unaltered.

The constant current dynamo shown in our illustration is fitted with a newly-designed automatic regulator, which consists of a solenoid in the main circuit, the core of which is connected by a rod with a double pawl, to which a rocking motion is transmitted from a vibrating lever and eccentric pin on the end of the armature spindle. The pawls work on two ratchet wheels, which are mounted upon the same spindle. When the current is of normal strength both pawls keep clear of the wheels and the regulator remains passive; but any rise or fall of current affects the core of the solenoid and causes the pawls to turn the ratchet wheels backward or forward, the motion being communicated to the brush-holder by means of a pinion and segment. To avoid the heavy sparking at the brushes which is usually attendant upon any attempt to regulate the current by shifting the brushes, Mr. Statter reduces the original strength of the field in the neighbourhood of the polar diameter by grooving the face of the polar cavity at that place, the position and size of the grooves having been determined by a series of tests determining the difference of potential between adjacent commutator plates at different angles.




During a series of tests in which the resistance of the external circuit (consisting of a number of Bernstein lamps, an arc lamp and iron coils) was varied in a number of ways, the regulator answered its purpose so well from full load to short circuit, that it is hardly worth while to give the readings. As this regulator keeps the current constant in spite of any variation in

speed, it is possible to drive these machines satisfactorily even with badly governed engines. The weight of the dynamo is 17½ cwt., and it is designed for a maximum output of 10 ampères at 600 revolutions. There are two or three peculiarities in its construction which are worth mention. In the first place the sectional area of the iron in the field magnets and armature is greater than that usually employed in machines for arc lighting, being, in fact, about the same as would be used for an incandescent lighting machine. Another point is that the magnetic resistance between pole and armature is reduced by the employment of Pacinotti teeth on the armature coil, such teeth, however, only extending about half the distance of the air space (or clearance) between armature core and field poles. The reason for this limited use of the teeth is that if such teeth are brought too near to field magnets of the powerful kind employed in this case heating takes place in them. A very good idea is carried out by dividing the commutator by grooves into three parts, practically making it three commutators, as the brushes work on only one of the three parts at a time. The system of winding and building the armature (Joel's patent) secures the best insulation, enables every coil to be fully tested before it is used, and facilitates the operation of putting together. The electrical efficiency of this machine is at the moderate speed of 600 revolutions, 91·8 per cent. which is unusually high for a slow speed arc light machine.

## THE ELECTRIC CURRENT AS A MEANS OF INCREASING THE TRACTIVE ADHESION OF RAILWAY MOTORS AND OTHER ROLLING CONTACTS.*

By ELIAS E. RIES.

THE object of this paper is to lay before you the results of some recent experiments in a comparatively new field of operation, but one that, judging from the results already attained, is destined to become of great importance and value in its practical application to various branches of industry.

I say "comparatively new" because the underlying principles involved in the experiments referred to have to a certain extent been employed (in, however, a somewhat restricted sense) for purposes analogous to those that form the basis of this communication.

As indicated by the title, the subject that will now occupy our attention is the use of the electric current as a means of increasing and varying the frictional adhesion of rolling contacts and other rubbing surfaces, and it is proposed to show how this effect may be produced both by means of the direct action of the current itself and by its indirect action through the agency of electro-magnetism.

Probably the first instance in which the electric current was directly employed to vary the amount of friction between two rubbing surfaces was exemplified in Edison's electro-motograph, in which the variations in the strength of a telephonic current caused corresponding variations in friction between a revolving cylinder of moistened chalk and the free end of an adjustable contact arm whose opposite extremity was attached to the diaphragm of the receiving telephone. This device was extremely sensitive to the least changes in current strength, and if it were not for the complication introduced by the revolving cylinder, it is very likely that it would to-day be more generally used.

It has also been discovered more recently that in the operation of electric railways in which the track rails form part of the circuit, a considerable increase in the tractive adhesion of the driving wheels is manifested, due to the passage of the return current from the wheels into the track. In the Baltimore and Hampden electric railway, using the Daft "third rail" system, this increased tractive adhesion enables the motors to ascend, without slipping, a long grade of 350 feet to the mile, drawing two heavily loaded cars, which result, it is claimed, is not attainable by steam or other self-propelling motors of similar weight. In the two instances just cited the conditions are widely different, as regards the nature of the current employed, the mechanical properties of the surfaces in contact, and the electrical resistance and the working conditions of the respective circuits. In both, however, as clearly demonstrated by the experiments hereinafter referred to, the cause of the increased friction is substantially the same.

In order to ascertain the practical value of the electric current as a means of increasing mechanical friction, and, if possible, render it commercially and practically useful wherever such additional friction might be desirable, as for example in the transmission of power, &c., a series of experiments were entered into by the author, which, though not yet fully completed, are sufficiently advanced to show that an electric current, when properly applied, is capable of very materially increasing the mechanical friction of rotating bodies, in some cases as much as from 50 to 100 per cent., with a very economical expenditure of current; this increase depending upon the nature of the substances in contact, and being capable of being raised by an increased flow of current.

Before entering into a description of the means by which this result is produced, and how it is proposed to apply this method practically to railway and other purposes, it may be well to give a general outline of what has so far been determined. These experiments have shown that the coefficient of friction between two conducting surfaces is very much increased by the passage therethrough of an electric current of low electromotive force and large volume, and this is especially noticeable between two rolling surfaces in peripheral contact with each other, or between a rolling and a stationary surface, as in the case of a driving wheel running upon a railway rail. This effect increases with the number of ampères of current flowing through the circuit, of which the two surfaces form part, and is not materially affected by the electromotive force, so long as the latter is sufficient to overcome the electrical resistance of the circuit. This increase in frictional adhesion is principally noticeable in iron, steel and other metallic bodies, and is due to a molecular change in the conducting substances at their point of contact (which is also the point of greatest resistance in the circuit), caused by the heat developed at that point. This heat is ordinarily imperceptible and becomes apparent only when the current strength is largely augmented. It is therefore probable that a portion of this increased tractive adhesion is due directly to the current itself aside from its heating effect, although I have not as yet been able to ascertain this definitely. The most economical and efficient results have been obtained by the employment of a transformed current of extremely low electromotive force (between ¼ and 1 volt), but of very large volume or quantity, this latter being variable at will so as to obtain different degrees of frictional resistance in the substances under observation.

These experiments were originally directed mainly toward an endeavour to increase the tractive adhesion of the driving wheels of locomotives and other vehicles, and to utilise the electric current for this purpose in such a manner as to render it entirely safe, practical and economical. It will be apparent at once that a method of increasing the tractive power of the present steam locomotives by more than 50 per cent. without adding to their weight and without injury to the roadbed and wheel tires such as is caused by the sand now commonly used, would prove of considerable value, and the same holds true with respect to electrically propelled street cars, especially as it has been found exceedingly difficult to secure sufficient tractive adhesion on street railways during the winter season, as well as at other times on roads having grades of more than ordinary steepness. As this, therefore, is probably the most important use for this application of the electric current, it has been selected for illustrating this paper.

I have here a model car and track arranged to show the equipment and operation of the system as applied to railway motors. The current in the present instance is one of alternating polarity which is converted by this transformer into one having the required volume. The electromotive force of this secondary current is somewhat higher than is necessary. In practice it would be about half a volt. You will notice upon a closer inspection that one of the forward driving wheels is insulated from its axle, and the transformed current, after passing to a regulating switch under the control of the engineer or driver, goes to this insulated wheel, from which it enters the track rail, then through the rear pair of driving wheels and axle to the opposite rail, and then flows up through the forward uninsulated wheel, from the axle of which it returns by way of a contact brush to the opposite terminal of the secondary coil of the transformer. Thus the current is made to flow seriatim through all four of the driving wheels, completing its circuit through that portion of the rails lying between the two axles, and generating a sufficient amount of heat at each point of contact to produce the molecular change before referred to. By means of the regulating switch the engineer can control the amount of current flowing at any time, and can even increase its strength to such an extent, in wet or slippery weather, as to evaporate any moisture, that may adhere to the surface of the rails at the point of contact with the wheels while the locomotive or motor car is under full speed.

It will be apparent that inasmuch as the "traction circuit" moves along with the locomotive, and is complete through its driving wheel base, the track rails in front and rear of the same are at all times entirely free from current, and no danger whatever can occur by coming in contact with the rails between successive motors. Moreover, the potential used in the present arrangement, while sufficient to overcome the extremely low resistance of the moving circuit, is too small to cause an appreciable loss of current from that portion of the rails in circuit, even under the most unfavourable conditions of the weather. In practice the primary current necessary is preferably generated by a small high-speed alternating dynamo on the locomotive, the current being converted by means of an inductional transformer. To avoid the necessity for electrically bridging the rail joints, a modified arrangement may be employed, in which the electrical connection is made directly with a fixed collar on the forward and rear driving axles, the current dividing itself in parallel between

* Read before the American Association for the Advancement of Science, New York Meeting, 1887.

the two rails in such a manner that, if a defective joint exists in the rail at one side, the circuit is still complete through the rail on the other; and as the rails usually break joints on opposite sides this arrangement is found very effective. The insulation of the driving wheels is very easily effected in either case.

As the amount of additional tractive adhesion produced depends upon the quantity of current flowing rather than upon its pressure, the reason for transforming the current as described will be apparent, and its advantages over a direct current of higher tension and less quantity, both from an economical and practical standpoint, will for this reason be clear. The amount of heat produced at the point of contact between the wheels and rails is never large enough to injure or otherwise affect them, although it may be quite possible to increase the current sufficiently to produce a very considerable heating effect. The amount of current sent through the traction circuit will of course vary with the requirements, and as the extent to which the resistance to slipping may be increased is very great, this method is likely to prove of considerable value. While in some cases the use of such a method of increasing the tractive power of locomotives would be confined to ascending gradients and the movement of exceptionally heavy loads, in others it would prove useful as a constant factor in the work of transportation. In cases like that of the New York elevated railway system, where the traffic during certain hours is much beyond the capacity of the trains, and the structure unable to support the weight of heavier engines, a system like that just described would prove of very great benefit, as it would easily enable the present engines to draw two or three additional cars with far less slipping and lost motion than is the case with mechanical friction alone, at a cost for tractive current that is insignificant compared with the advantages gained. Other cases may be cited in which this method of increasing friction will probably be found useful, aside from its application to railway purposes, but these will naturally suggest themselves and need not be further dwelt upon.

In the course of the experiments above described, another and somewhat different method of increasing the traction of railway motors has been devised, which is more particularly adapted to electric motors for street railways, and is intended to be used in connection with a system of electric street railways now being developed by the writer. In this system electro-magnetism provides the means whereby the increase in tractive adhesion is produced, and this result is attained in an entirely novel manner. Several attempts have heretofore been made to utilise magnetism for this purpose, but apparently without success, chiefly because of the crude and imperfect manner in which most of these attempts have been carried out.

The present system owes its efficiency to the formation of a complete and constantly closed magnetic circuit, moving with the vehicle and completed through the two driving axles, wheels, and that portion of the track rails lying between the two pairs of wheels, in a manner similar to that employed in the electrical method before shown. We have here a model of a second motor car equipped with the apparatus, mounted on a section of track and provided with means for measuring the amount of tractive force exerted both with and without the passage of the current.

You will notice that each axle of the motor car is wound with a helix of insulated wire, the helices in the present instance being divided to permit the attachment to the axles of the motor connections. The helices on both axles are so connected that, when energised, they induce magnetic lines of force that flow in the same direction through the magnetic circuit. There are, therefore, four points at which the circuit is maintained closed by the rolling wheels, and as the resistance to the flow of the lines of force is greatest at these points, the magnetic saturation there is more intense and produces the most effective result just where it is most required. Now when the battery circuit is closed through the helices, it will be observed that the torque, or pull, exerted by the motor car is fully twice that exerted by the motor with the traction circuit open, and by increasing the battery current until the saturation point of the iron is reached, the tractive force is increased nearly 200 per cent., as shown by the dynamometer. A large portion of this resistance to the slipping or skidding of the driving wheels is undoubtedly due to direct magnetic attraction between the wheels and track, this attraction depending upon the degree of magnetic saturation and the relative mass of metal involved. But by far the greatest proportion of the increased friction is purely the result of the change in position of the iron molecules, due to the well-known action of magnetism, which causes a direct and close interlocking action, so to speak, between the molecules of the two surfaces in contact. This may be illustrated by drawing a very thin knife blade over the poles of an ordinary electro-magnet, first with the current on, and then off.

In the model before you the helices are fixed firmly to, and revolve with, the axles, the connections being maintained by brushes bearing upon contact rings at each end of the helices. If desired, however, the axles may revolve loosely within the helices, and instead of the latter being connected for cumulative effects, they may be arranged in other ways so as to produce either subsequent or opposing magnetic forces, leaving certain portions of the circuit neutral and concentrating the lines of force wherever they may be most desirable. Such a disposition will prove of advantage in some cases.

The amount of current required to obtain this increased adhesion in practice is extremely small, and may be entirely neglected when compared to the great benefits derived. The system is very simple and inexpensive, and the amount of traction secured is entirely within the control of the motor-man, as in the electric system. It will be seen that the car here will not, with the traction circuit open, propel itself up-hill when one end of the track is raised more than 5 inches above the table; but with the circuit energised it will readily ascend the track as you now see it, with one end about 13½ inches above the other in a length of three feet, or the equivalent of a 30 per cent. grade; and this could be increased still further if the motor had power enough to propel itself against the force of gravity on a steeper incline. As you will notice, the motor adheres very firmly to the track and requires a considerable push to force it down this 40 per cent. grade, whereas with the traction circuit open, it slips down in very short order, notwithstanding the efforts of the driving mechanism to propel it up.

The resistance of the helices on this model is less than two ohms, and this will scarcely be exceeded when applied to a full-sized car, the current from two or three cells of secondary batteries being probably sufficient to energise them.

The revolution of the driving axles and wheels is not interfered with in the slightest, because in the former the axle boxes are outside the path of the lines of force, and in the case of the latter because each wheel practically forms a single pole piece, and in revolving presents continuously a new point of contact, of the same polarity, to the rail; the flow of the lines of force being most intense through the lower half of the wheels, and on a perpendicular line connecting the centre of the axle with the rail. In winter all that is necessary is to provide each motor car with a suitable brush for cleaning the track rails sufficiently to enable the wheels to make good contact therewith, and any tendency to slipping or skidding may be effectually checked. By this means it is easily possible to increase the tractive adhesion of an ordinary railway motor from 50 to 100 per cent., without any increase in the load or weight upon the track; for it must be remembered that even that portion of the increased friction due to direct attraction does not increase the weight upon the road-bed, as this attraction is mutual between the wheels and track rails; and if this car and track were placed upon a scale and the circuit closed, it would not weigh a single ounce more than with the circuit open.

It is obvious that this increase in friction between two moving surfaces can also be applied to check, as well as augment, the tractive power of a car or train of cars, and I have shown in connection with this model a system of braking that is intended to be used in conjunction with the electro-magnetic traction system just described. You will have noticed that in the experiments with the traction circuit the brake-shoes here have remained idle; that is to say, they have not been attracted to the magnetised wheels. This is because a portion of the traction current has been circulating around this coil on the iron brake beam, inducing in the brake-shoes magnetism of like polarity to that in the wheels to which they apply. They have therefore been repelled from the wheel tires instead of being attracted to them. Suppose now that it is desired to stop the motor car, instead of opening the traction circuit, the current flowing through the helices is simply reversed by means of this pole-changing switch, whereupon the axles are magnetised in the opposite direction and the brake-shoes are instantly drawn to the wheels with a very great pressure, as the current in the helices and brake coil now assist each other in setting up a very strong magnetic flow, sufficient to bring the motor car almost to an instant stop, if desired.

The same tractive force that has previously been applied to increase the tractive adhesion now exercises its influence upon the brake-shoes and wheels, with the result of not only causing a very powerful pressure between the two surfaces due to the magnetic attraction, but offering an extremely large frictional resistance in virtue of the molecular interlocking action before referred to. As shown in the present instance, a portion of the current still flows through the traction circuit and prevents the skidding of the wheels.

The method thus described is equally applicable to increase the coefficient of friction in apparatus for the transmission of power, its chief advantage for this purpose being the ease and facility with which the amount of friction between the wheels can be varied to suit different requirements, or increased and diminished (either automatically or manually) according to the nature of the work being done. With soft iron contact surfaces the variation in friction is very rapid and sensitive to slight changes in current strength, and this fact may prove of value in connection with its application to regulating and measuring apparatus. In all cases the point to be observed is to maintain a closed magnetic circuit of low resistance through the two or more surfaces the friction of which it is desired to increase, and the same rule holds good with respect to the electric system, except that in the latter case the best effects are obtained when the area of surface in contact is smallest. For large contact areas the magnetic system is found to be most economical, and this system might possibly be used to advantage to prevent slipping of short wire ropes and belts upon their driving pulleys, in cases where longer belts are inapplicable, as in the driving of dynamos and other machinery. Experiments have also been, and are still being, made with the object of increasing friction by means of permanent magnetism, and also with a view to diminishing the friction of revolving and other moving surfaces, the results of which will probably form the subject matter of a subsequent paper.

Enough has been said to indicate that the development of these two methods of increasing mechanical friction opens up a new and extensive field of operation, and enables electricity to score another important point in the present age of progress. The great range and flexibility of this method peculiarly adapt it to

the purposes we have considered and to numerous others that will doubtless suggest themselves to you. Its application to the increase of the tractive adhesion of railway motors is probably its most prominent and valuable feature at present, and is calculated to act as an important stimulus to the practical introduction of electric railways on our city streets, inasmuch as the claims heretofore made for cable traction in this respect are now no longer exclusively its own. On trunk line railways the use of sand and other objectionable traction-increasing appliances will be entirely dispensed with, and locomotives will be enabled to run at greater speed with less slipping of the wheels and less danger of derailment. Their tractive power can be nearly doubled without any increase in weight, enabling them to draw heavier trains and surmount steeper grades, without imposing additional weight or strain upon bridges and other parts of the road-bed. Inertia of heavy trains can be more readily overcome, loss of time due to slippery tracks obviated, and the momentum of the train at full speed almost instantly checked by one and the same means.

## AN ANALYSIS OF DYNAMO DESIGN.*

By FRANK C. WAGNER, Hempstead, L. I.

MOST of the writers upon the theory of dynamo design leave an undetermined factor in their formulæ, which depends upon the form and dimensions of the dynamo. This factor is commonly determined by experiment, and corresponds to the G of Prof. S. P. Thompson, or the M of Dr. Fröhlich. Of course, if one has plenty of time and money, it is possible to build a new type of dynamo by going through a series of experiments to determine the best proportions. But the more scientific way would be to inquire into the manner in which the form and dimensions influence the value of this undetermined factor, and to determine quantitatively their effect. Then a new type or size of dynamo could be designed with the same precision as any other engineering structure, and data would be at hand for criticising and comparing different types of dynamos. Some good work has already been done along this line, especially by Mr. Kapp and Dr. Hopkinson, of England.

In the following I shall try to show how the output of a dynamo may be determined from its form and dimensions, including the windings of the magnets and armature, when its speed and the current, if a constant current machine, or the electromotive force, if a constant potential, is given. The absolute or C.G.S. system of units is used throughout.

Let us take, for example, a series-wound dynamo working at constant current. Let C be the value of this current in absolute units. Let H be the total number of lines of force, or total magnetic induction (absolute units) enclosed by the average turn of wire on the armature when it is perpendicular to their direction. Let $n$ be the total number of turns of wire on the armature. Let N equal the number of revolutions of the armature per second. Then, if E is the total induced electromotive force,

$$E = 4 N n H. \qquad (1)$$

To obtain the value of H:—Let $n'$ equal the entire number of turns of wire upon the two field magnets when they are coupled in series. If the current is divided between the two field magnets, $n'$ will represent one-half the total number of turns. The magnetic force, to use Maxwell's term (perhaps a less ambiguous term would be magnetomotive force), will then be $M = 4 \pi n' C$. Now comes the undetermined factor. What is the ratio of the magnetic induction to the magnetic, or magnetomotive force? In this connection let me quote from Clerk Maxwell's *Treatise on Electricity and Magnetism*, Vol. II., Art. 428: "The magnetic induction is a quantity of the nature of a flux, and satisfies the same conditions of continuity as the electric current does."

"In isotropic media the magnetic induction depends on the magnetic force in a manner which exactly corresponds with that in which the electric current depends on the electromotive force."

Now, if we wind a soft iron ring with a number of turns of wire, and send a current through the wire, the magnetic induction may be said to pass through an isotropic medium. It may, therefore, be calculated from the impressed magnetomotive force and the magnetic resistance of the magnetic circuit. This magnetic resistance is calculated from the length and cross section of the iron, its specific magnetic resistance being known in exactly the same way as electrical resistance. Now, let us cut a small piece out of our iron ring. We have introduced the resistance of air in place of that of the iron. The magnetic resistance of the circuit is now made up of two terms, the resistance of the iron and that of the air space. This may be calculated in the same way as the electrical resistance of a circuit made up of metals of different conductivities, provided that the air resistance is not too great in comparison with the resistance of the iron portion of the circuit. Then we will have the magnetic resistance made up of terms like $\frac{l}{M A}$; where $l$ is the length of the body parallel to the lines of magnetic induction; M is the coefficient of permeability; and A is the cross section perpendicular to the lines of force.

In a well constructed dynamo the air resistance should be of the same order of magnitude as the magnetic resistance of the iron portion. Hence this simple method of calculation may be applied to determine the magnetic induction in a dynamo. We have then:—

$$H = \frac{M}{Q} = \frac{M}{\frac{l_0}{A_0} + \frac{l_1}{M_1 A_1} + \frac{l_2}{M_2 A_2} + \&c.} \qquad (2)$$

$$= 4 \pi n' C \left[ \frac{1}{\frac{l_0}{A_0} + \frac{l_1}{M_1 A_1} + \&c.} \right]$$

$$\therefore E = 4 N n \times 4 \pi n' C \left[ \frac{1}{\frac{l_0}{A_0} + \frac{l_1}{M_1 A_1} + \&c.} \right] \qquad (3)$$

$$= 16 N n n' \pi C \left[ \frac{1}{\frac{l_0}{A_0} + \frac{l_1}{M_1 A_1} + \&c.} \right]$$

—a formula in which all the quantities are known from the form and dimensions of the dynamo, and from the electrical and mechanical conditions under which it works.

To make this method of calculation more clear, I will apply it to an example. The following data are taken from an actual dynamo running under the assumed conditions:—

$$n' = 3{,}990 \qquad C = 68 \qquad \therefore M = 4 \pi n' C = 34{,}095.$$

To calculate the magnetic resistance let me begin with the air space between the poles and the armature coil; for the greater part of the resistance should be found here.

$l_0 = 4{\cdot}44$ cm. for one side, or $8{\cdot}88$ cm. for two.

$A_0 = 1{,}772$ sq. cm. $\quad \therefore \frac{l_0}{A_0} = {\cdot}0049.$

We will next take the armature core. This consists of a ring of many turns of soft iron wire. The sectional area of this ring is $49{\cdot}12$ sq. cm., but since the magnetic induction divides in passing through the core, the effective cross section will be twice this, or $98{\cdot}24$ sq. cm.

From this it is readily seen that the armature core is saturated. Assuming a maximum intensity of magnetism for soft iron wire of 20,000, we have a total induction through the armature core of 1,964,800, which gives an equivalent resistance of ·015.

Since the armature core is saturated, the air space inside the iron wire becomes important. For this:—

(mean) $l = 30{\cdot}5$ cm.; $A_2 = 793{\cdot}3$ sq. cm.

$$\therefore \frac{l_2}{A_2} = {\cdot}0384.$$

For the air resistance in the space occupied by the copper wire of the armature:

$l_3 = 27\,9$ cm.; $A_3 = 175{\cdot}5$ sq. cm.

$$\therefore \frac{l_3}{A_3} = {\cdot}159.$$

For the annular air space outside of the windings and between the poles:

$l_4 = 15{\cdot}25$; $A_4 = 512{\cdot}7$ sq. cm.

$$\therefore \frac{l_4}{A_4} = {\cdot}0297.$$

The entire magnetic resistance between the poles is that due to three parallel circuits—that through and inside the iron core, that through the copper wire on the armature, and that entirely outside the armature. The resistance through and within the iron core is:

$$\cdot0049 + \frac{1}{\frac{1}{\cdot015} + \frac{1}{\cdot0384}} = \cdot0049 + \cdot0108 = \cdot0157$$

The combined resistance would then be:

$$\frac{1}{\frac{1}{\cdot0157} + \frac{1}{\cdot159} + \frac{1}{\cdot0297}} = \cdot00965$$

The resistance from pole to pole of a dynamo is the largest part of the entire magnetic resistance. Hence if we divide the magnetomotive force by this resistance we shall get an approximate value for the magnetic induction.

Thus $\frac{34{,}095}{\cdot00965} = 3{,}533{,}000$, C. G. S. units.

We have next to find the magnetic resistance of the iron portion of the circuit. First the cores, which are of cast iron. $l_5 = 25$ 4 cm. for one core; $A_5 = 644{\cdot}5$ sq. cm. The permeability of the iron depends upon its intensity of magnetisation, which is

* Read before the American Association for the Advancement of Science. New York, August, 1887.

$\frac{3,533,000}{644·5} = 5,480$. The writer has constructed curves from the experiments of Rowland and Bosanquet, showing the dependence of the permeability upon the intensity of magnetisation for different kinds of iron. Referring to the curve for medium cast iron, $M_5$ is found to be 180. $\therefore \frac{l_5}{M_5\ A_5} = ·000220$. For the two cores this would be ·00044.

We have next the wrought iron bars forming the yoke. For this

$$l_6 = 92·71 \text{ cm.} \quad A_6 = 279·3 \text{ square cm.}$$

The intensity of magnetisation is

$$\frac{3,533,000}{279·3} = 12,650$$

Referring to the curve for Swedish charcoal iron, we have:

$$M_6 = 1,400. \quad \therefore \frac{l_6}{M_6\ A_6} = ·000237.$$

For the total resistance of the magnetic circuit we have then:

$$·00965 + ·00044 + ·000237 = ·010327.$$

Hence the total magnetic induction will be:

$$H_1 = \frac{M}{Q} = \frac{34,095}{·010327} = 3,300,000.$$

Now, the magnetic induction inside the wire of the armature is:

$$H_1 = \frac{1}{\frac{·01571}{\frac{1}{·0157} + \frac{1}{·159} + \frac{1}{·0297}}} \times H_1 = \frac{63·7}{103·7} \times H_1 = 2,027,000.$$

The induction through the space occupied by the copper wire is $H'' = \frac{1}{\frac{·159}{103·7}} \times H_1 = 200,200$. It may be assumed that one-half of this is cut by the mean coil of the armature. Then the total effective magnetic induction of the field magnets is $H' = H + \frac{H''}{2} = 2,127,100$.

There is still another component of the effective magnetic induction. When the dynamo is in operation the current through the armature causes a magnetic induction in the space between the pole pieces. The value of this is readily calculated as follows: In this particular dynamo there are three sections, of which two are always connected in parallel with each other and in series with the third. The magnetic induction of this third coil is readily found in the same way as the main magnetic circuit. It is evident that the air space is here the chief resistance. We have:—

$l_0 = 8·88$ cm. $\quad A_0 = 635·8$ sq. cm. $\quad \therefore \frac{l_0}{A_0} = ·014. \quad n_1 = 1,333:$

$c = ·68. \quad \therefore 4\pi n_1 c \left[\frac{1}{\frac{l_0}{A_0}}\right] = 815,500.$ For each of the other two coils carrying one-half the main current, the induction would be 407,750.

Assuming a certain position of the armature, the directions of these several magnetic inductions are known and they can be combined as *vectors*. Making this combination for a number of positions within an arc representing a complete cycle of conditions—in this case an arc of 60°—and finding the mean of the resultant vectors, we shall have the resultant magnetic induction both in direction and magnitude. In this case the resultant induction, found graphically, is 2,611,000. It is obvious that this graphical construction will give the lead of the brushes corresponding to a maximum load on the dynamo.

It remains to find the electromotive force induced in the armature by this magnetic field. The commutator of the dynamo is so arranged that each coil in passing from a position making an angle of 30° with the magnetic induction on one side to 30° on the other side, is connected in series. While passing from an angle of 30° to a perpendicular position, it is connected in parallel with another coil passing from a perpendicular to 30° on the other side. The number of lines of force cut in a half-revolution will then be $n\,H\,[2\cos 30° + 2\,(1 - \cos 30°)] = n\,H \times 1·134$. Let $n$ = number of revolutions per second = 14·17. Then $E$, the total induced electromotive force in absolute units = $2\,N\,n\,H \times 1·134 = 336,000,000,000$; or in volts $E = 3,360$.

The class of dynamos to which the above analysis was applied, carry from 55 to 58 arc lights before heating up. With 52 volts to a lamp this means an external electromotive force of from 2,860 to 3,016 volts. The resistance of the dynamo cold is 57 ohms. Hence it absorbs a difference of potential of 388 volts. And the total E.M.F. generated is from 3,250 to 3,400 volts.

The above method has also been applied to an incandescent dynamo by the writer with an equally close agreement with experimental results. It can be applied to the design of electro-magnets to be employed for any purpose; enabling one to determine the shape and dimensions of the iron, which will give a maximum magnetic effect for a given expenditure of electrical energy. It is also applicable in the determination of the self-induction and mutual induction of electro-magnets.

## ELECTRIC LIGHTING IN KENT.

A CANTERBURY correspondent writes as follows:—So far as Kent is concerned, the enterprising little town of Herne Bay has taken the lead in electric lighting. Mr. W. Hamilton, an electrical engineer, has resided there for some years, and has introduced the electric light, which can be supplied at a cost about 20 per cent. less than that of gas, for which the local gas company charge 4s. 9d. per 1,000 cubic feet. The light will be supplied to hotels, shops and private houses. The incandescent lamps invented by Mr. Hamilton, and the arc lamps manfactured by Pieper (Berlin) will be used. From Herne Bay a wire can, if necessary, be laid to Herne Street, for the purpose of lighting that village and the mansion at Strode Park, now occupied by Major Davies, Sheriff of London and Middlesex. The incandescent lamps were patented by Mr. Hamilton in 1883. Existing gas fittings can be utilised, but where no fittings exist, the electric light lamps are suspended from the ceiling by wires of different colours artistically braided, or can be fitted in other ways. It is proposed by Mr. Hamilton to establish at Herne Bay a factory for the purpose of manufacturing his lamps and other goods, such as accumulators, dynamos, and electrical fittings generally. At present, one of Hornsby's 26-horse-power engines is in use, and it is intended to duplicate the plant, so that in the event of a breakdown, a constant supply may be maintained. It is also proposed to use storage batteries.

In the opinion of electricians, the Mayor of Folkestone has over-estimated the cost of lighting the Lees by electricity. It would appear that he put the cost of 30 lamps of 200 candle-power at from £700 to £800 a year for nine hours a night. Now one arc lamp of 1,000 candle-power will light a space of from 20,000 to 30,000 square yards in a manner far superior to gas. Supposing we take a strip of ground 130 yards wide, one row of lamps placed down the centre at intervals of 130 yards apart will light it most brilliantly. At the rate charged at Herne Bay—£20 a year for one arc lamp of 1,000 candle-power during shop hours, about 1,250 hours a year—the cost of lighting 10 arc lamps of 1,000 candle-power would be £550; and these lamps would brilliantly illuminate nearly a mile of the Lees, giving 4,000 candle-power more than the 30 lamps the Mayor mentioned. Not only would the electric light be superior to gas on land, but it would light up the sea for a very considerable distance. At Herne Bay the fishermen say the electric light is of the greatest possible service to them, as it enables them to work after dark. The light would illuminate the sea—sufficiently to enable the fishermen to see what they were doing—to a distance of a mile from the shore at Folkestone. For the last five weeks of the season this year the Tower Gardens and Parade at Herne Bay were lighted by electricity. Four lamps, each of 2,000 candle-power, were put up on poles about 30 feet from the ground. During a heavy breeze the electric light was absolutely steady, and presented a decided contrast to the flickering gas lamps. It was on the occasion of the Jubilee celebrations, and in the following week, that the light was first shown in Herne Bay. Already most of the leading tradesmen of Herne Bay show an inclination to adopt electric lighting, and there seems every prospect of the Herne Bay Electric Lighting Company being fully employed during the winter.

## THE WESTINGHOUSE SYSTEM OF ELECTRIC LIGHTING.

By G. L. ADDENBROOKE.

THE electrical and scientific world is certainly indebted to Mr. Pope for his clear and able exposition of the system pursued by the Westinghouse Company,* and the principles which have guided them in working out the eminently simple method of using alternating current dynamos and transformers, which they have adopted in America with such striking success for electric lighting.

Mr. Pope has now done for the Westinghouse system what Messrs. Zipernowsky, Deri and Blathy have done for theirs. While they, however, had to devote a great deal of space to showing that their system was practical and could only draw experience from a few installations, Mr. Pope has no need to demonstrate the feasibility of the thing that is already a thoroughly accomplished fact, and he has the experience to draw from which the knowledge gained in the manufacture and installation of nearly 100,000 lights has given.

In nothing more than in electricity, or, at all events, in electrical engineering, is the maxim true that mathematics are an excellent servant but a bad master. For some time past now we have had many learned disquisitions on the action of alternating currents under many different aspects: but while these treatises have had their value from a theoretical point of view, they

* See ELECTRICAL REVIEW for September 30th, 1887.

have not been marked by that practical familiarity with the subjects with which they dealt, which daily experience on a commercial scale gives.

Literature of this sort suffers from what may, in default of a better term, be called "want of balance." In it complicated subsidiary effects, which in practice only come in as small percentage factors, are often treated with much minuteness and at great length.

The main points, then, being of a simple nature and easily explained, as most great truths are, occupy so small a share of the letterpress and mathematics that the student or general reader, unguided by experience, will often quite lose all sense of proportion in the subject he is pursuing. He is thus led to foresee difficulties and uncertainties where such do not really exist; while, on the other hand, the real difficulties which occur in practice are often so obscurely stated, if mentioned at all, that there is danger of being thrown off the track in endeavouring to reduce the problem to a commercial shape.

For these reasons this contribution of Mr. Pope's is welcome as returning once more directly to the subject; and, further, because at the same time his article gives an exposition of the principles involved in this system of lighting, which is capable of being grasped by engineers generally and the more intelligent portion of the non-technical public.

Passing now from the system itself as described by Mr. Pope to the apparatus by which it is carried out as manufactured by the Westinghouse Company, the first point deserving attention is the dynamo. In this the Siemens type, as usually employed with various modifications in Europe, is considerably departed from. Instead of the alternate poles of the field magnets being set opposite each other, as in the Siemens type, with a narrow space between for the armature coils to revolve in, the magnets are set side by side with their faces pointing inwards around the outside of the armature, which is of the drum type. As far as the field magnets are concerned, the chief objection which can be urged against this arrangement is a certain tendency to magnetic short circuit. That is each N pole having a S pole on either side of it, and the poles having some inclination towards each other, there will be a strong tendency for a large number of the lines of force to pass through the intervening air space direct instead of cutting the wire of the armature, magnetising the iron beneath it, and then out again, so to speak, to the neighbouring pole on either side. The diagrams given by Mr. Pope and his explanations, admirable as they are on most points, are somewhat incomplete on this, and in the absence of measurements and fuller particulars it is not possible to say what loss may take place on this account. As, however, the watts taken for the exciting current do not exceed 2 per cent. of the watts the machine gives at its full load, waste from this magnetic short circuiting may occur without seriously detracting from the efficiency of the machine.

Further, owing to the small size of the armature its periphery velocity is low, and consequently the speed has to be high to give the requisite E.M.F., 1,000 volts. The armature itself seems to be a very solid piece of work, and if it keeps fairly cool should wear well. I should imagine such a construction would hardly bear a higher number of volts permanently than that for which it is actually made. The reports of burnt armatures in the American electrical papers, which have once or twice rather inadvertently come to light, bear out this supposition, though no doubt manufacturing improvements will soon reduce this risk. Next to altogether avoiding the chance of burning a coil in an armature, the best thing is to be able to quickly replace one which has been burnt. It would be interesting to know how this is done and how long it takes in the Stanley machine. Apparently it could only be done in a machine shop with proper appliances. Otherwise there is no doubt that the machine is very open and favourably constructed for inspecting the working parts while in motion, a very important point, often less thought of by dynamo makers than it should be. To be able to get a clear view in a moment of all working parts, is the best preventive of accidents which can be devised.

In the drawing of the machine 16 field magnets are shown, and it is stated that with the 650 and 1,300-light machines the number of revolutions is 1,650 per minute; this gives the large number of 20,400 alternative, 40,800 reversals, per minute, or 680 per second, which strikes one as being a very high, an unnecessarily high number.

As regards the transformer, it is obviously a much more workman-like and practical piece of apparatus than the Gaulard & Gibbs pattern, under the patents for which it is constructed. No doubt it works perfectly well; indeed, transformers are so simple an arrangement of iron and wire that, now the principles which regulate their construction are well known and clearly defined, it seems as if it would be difficult to make anything which would not work. It is with transformers as with dynamos.

The principles which govern their action once understood, dynamos can be constructed with different arrangements of armature and field magnets, which, supposing the workmanship in each case equal, will all give in practice almost precisely equal results.

The points which need attention in a commercially successful transformer, besides the satisfaction of the electrical conditions, are:

1. Protection of the coils from damp or wet. If damp or wet gets to the primary coils, short circuiting and consequent cutting of the transformer out of the circuit is sure to be the result. If the current is always passing through the transformer protection is not of such material importance, as the expenditure of energy in the transformer is always sufficient to keep it pleasantly warm and consequently dry.

2. Proper insulation of the primary and secondary coils from each other, and the arrangement of the primary so that points of too high potential are not brought electrically near each other. As the teaching of the Law and the Prophets was summed up in a short sentence, so the maxims regarding transformers may be summed up in the apostrophe:—Beware of damp and short circuits, keep points of greatly differing potential separate, and avoid contact between primary and secondary.

Anything approaching short circuit of a coil is instantly fatal, because the short circuited portion acts as a closed secondary to the other coils, which leads to almost instant fusion somewhere. Respecting contact between the primary and secondary, this is the point to guard against in working a transformer system on a large scale. As I pointed out a few weeks ago, the actual insulation of an extended series of mains cannot be very high in damp weather, although the specific insulation may be so. There will consequently always be a strong tendency in the mains for the current to go to earth. Now the style of work usual in installations, however ample it may be to stand the voltage it is intended for, is hardly ever calculated to endure the tension of the mains in a transformer system, therefore if there is any weakness between the primary and secondary coils in the transformer the main current is not unlikely to go to earth through the secondary somewhere or other in an installation. Of course this happening would soon cause the cut-outs to fuse, but still someone in the meantime may get a pretty severe shock, or something else may happen of an unpleasant nature.

I do not wish to say anything of an alarmist character—there is no need for it; but as every accident which now happens is so much against the system generally, it is important that inventors should not neglect to take proper precautions under this heading, seeing that they are sufficiently simple, so as to obviate any chance of an accident of this kind.

3. The third point is good ventilation. No special arrangement seems to be made for this in the Westinghouse type of transformer. As apparently, so far, only comparatively small transformers seem to have been made of this pattern, the question no doubt has not particularly needed to be dealt with, but with larger

sizes they will probably have to make some arrangements by which cooling can take place more rapidly than it could do through the sides of a completely closed iron box. It is obviously most important that the temperature should never reach the point when carbonisation of the insulating material commences, as then all insulation is soon at an end.

The little connecting and cut-out boxes fitted in the transformer case are particularly neat and compact. Apparently from the construction there is no separate switch used for disconnecting the mains when the transformer is not in use. It would be interesting to learn how the cut-outs act in these boxes, whether the glass front is blown out when they go, or what occurs. There are some curious points about the action of cut-outs when currents of high tension are used which need elucidating, and which, if properly investigated, would not improbably lead to conclusions of considerable theoretical, if not practical, importance. Placing transformers on poles is a happy idea; and evidently, from the photographic illustrations given with Mr. Pope's article, when thus placed, they are not so unsightly as one would at first imagine. Although such a method is hardly applicable to a large town, yet for small ones and villages it appears eminently practical. How many small communities in our own hilly districts could easily and cheaply obtain all the advantages of electric illumination in such a manner, the power being supplied from some neighbouring mill stream.

It is not a very complimentary reflection for European electricians and capitalists that although all the ideas and experimental work needed for the development of the transformer system of electric light have come from Europe, and although Messrs. Zipernowski, Deri and Blathy demonstrated commercially the perfect practicability of working transformers in parallel two years ago, it should be reserved for an American firm to take up the system and make it the commercial and practical success which the Westinghouse Company is now doing.

## NOTES.

**Electric Lighting in Birmingham.**—An installation of electric lighting has just been carried out for the Linde British Refrigeration and Ice Company, Limited, at its works in the sub-basement of the New Fish Market, Birmingham, by Chamberlain and Hookham, Limited, of that town. The motive power is taken by means of a counter-shaft from the large engine used by the Linde Company in the manufacture of ice. The electric current is generated by two "Hookham" patent dynamos, the one a ¾ unit capable of supplying 12 55-volt 16 C.P. lamps, the other a 2 unit capable of supplying 30 55-volt 16 C.P. lamps. Each lamp is controlled by a separate switch, and the whole is operated by a main switch in the engine room. The machines, which are driven from the countershaft by means of cotton ropes ½ inch and ⅜ inch in diameter respectively, are arranged to be worked alternately in day and night shifts by means of a friction clutch arrangement provided for the purpose. The processes of the Linde Refrigeration Company require to be carried on continuously both by day and night in a sub-basement which has no natural light. Under these circumstances the company's ordinary engines are utilised as motive power for the electric light plant, and the only cost incurred is that of the extra coal burnt, and the interest and sinking fund on the first cost of the installation. These items together amount to an annual charge of less than one-fourth of that which would be incurred on gas lighting at 2s. 2d. per 1,000 cubic feet. The whole of the work has been carried out under the superintendence of Mr. C. W. Vollman, assistant engineer of the Linde Refrigeration Company, Limited.

**Fire Risks with Electric Lighting.**—Mr. Musgrave Heaphy has written to the Anglo-American Brush Corporation, in response to enquiries, to the following effect:—"An electric light installation thoroughly well put up with the best quality of workmanship and materials, and in accordance with the fire rules, forms one of the most secure of all methods of lighting, so much so, that it is being allowed in buildings without any extra charge for insurance, notwithstanding that gas and other illuminants are used concurrently. On the other hand, an electric light installation improperly put up, and where the quality of materials and workmanship employed are not of the best, renders a building extremely hazardous so far as an outbreak of fire is concerned. Fires have occurred through the electric light which would not have happened if the installations had been arranged securely, and they have broken out, too, in such places as between floors and ceilings, behind wainscotings and under roofs. My advice is, that any intending user of the electric light should determine to have it put up in the best possible manner, with the best materials and workmanship, or else should give up all idea of having it. Should he not do this he will forfeit the important advantages arising from its use."

**Electric Lighting in Brussels.**—A *Times* telegram from Brussels says:—"The general use of electric lighting has made a great step forward. The General Company of Electricity, of Berlin, with a fully-paid up capital of £250,000, has issued £350,000 of additional shares at a rate of 122 for 100. £40,000 worth was taken beforehand by MM. Siemens and Halske, and the rest is subscribed for several times over, all fully paid. The purpose is the working of central stations in Germany and other countries."

**Arc Lamps Wanted.**—Tenders are required for the erection and supply by electric light of six electric lamps, of 3,000 candle-power each, in such positions in the city of Londonderry as may be agreed and decided on, for the Corporation of Londonderry. Tenders, sealed and endorsed "Tenders for electric light," to be lodged with Mr. R. N. Chambers, town clerk, 28, Bishop Street, Londonderry, by 14th inst.

**Electric Lighting in Hamburg.**—In this city there are 78 electric light installations employing 325 arc and 5,300 incandescence lamps. The motors aggregate about 1,000 horse-power, a fifth of which is supplied by gas engines.

**Electric Lighting in Germany.**—From a report drawn up by Dr. Schilling it appears that in the thirteen principal towns there are in use 3,280 arc and 50,469 incandescence lamps. The number of gas jets in these towns amounts to a total of 1,221,882.

**Electric Lighting in Peru.**—It is stated that the electric light installation in Lima, the capital of Peru, has failed to give satisfactions, and that a return to gas lighting is probable.

**The Telephone at Stafford.**—Some months ago the National Telephone Company decided to stir Stafford people out of their lethargy, and call their attention to the desirability of establishing a local exchange for the town and district. Public meetings were held, and after some time the company got a sufficient number of subscribers to warrant it in commencing operations. For several weeks past the employés of the company have been busy connecting the residences and offices of the subscribers with the central office in Greengate Street, and fixing the telephone instruments in position. Last week the exchange was in practical working order and ready for the use of subscribers. Trunk lines connecting Stafford with Birmingham,

Stone, the Potteries, and the northern towns are contemplated. The central office has been located at Mr. J. J. Jervis's, stationer, in Greengate Street, where the general public, for the small sum of 3d., can communicate with any subscriber for three minutes. A call station is also placed at the cabmen's rest near the railway station. The formal opening of the exchange was made on Wednesday, last week, at the house of Mr. W. O. Rooper, C.E., who has throughout taken an active part in furthering the formation of the scheme. The Mayor of Stafford (Ald. W. H. Peach) was selected to send the first message, and a large number of local gentlemen were present at the ceremony. Mr. Alfred Coleman, general manager to the National Telephone Company, and Mr. Alfred L. E. Drummond, district manager were also present. The mayor said the practical utility of the system of telephone exchanges was demonstrated in nearly every large commercial city in the Empire, and it was to him a sign that Stafford was not going backwards to find so many enterprising citizens desiring to participate in the benefits of the telephone. He hoped before long that when the town was connected with the Potteries, many business men from that district would come to reside at Stafford, since communication between their homes and business places could be conveniently attained by means of the telephone. As they would see from the plan of the various "trunk lines," when Stafford was connected on the one hand with Wolverhampton and Birmingham and on the other hand with the Potteries, communication would at once be opened with a great many large towns all over the country, and people would be able to talk from Stafford to their friends or business people a hundred miles off. Mr. Coleman said they were about to open a small exchange in Stafford, and they felt sure that as soon as it was opened the business public would at once perceive its great convenience and adopt it generally. That had been their experience everywhere it had been tried hitherto. The trunk line would be commenced as soon as sufficient support was obtained. Subscribers to the local exchange would have the privilege of using the trunk line to Stone at an annual rate of £3, to the Potteries of £7, and to Birmingham and the Black Country of £10. Or if they did not pay an annual subscription they could pay 6d. each message of three minutes to Stone, the Potteries, Wolverhampton, Birmingham and the Black Country, Burton and Derby; 9d. each message to Buxton, and 1s. each message to Lancashire, Yorkshire and Derbyshire towns. The visitors then proceeded to Mr. Rooper's dining-room, where one of the ordinary exchange instruments was affixed. At the request of Mr. Coleman, the mayor "rang up" the central office, and requested to be "hitched on" to the police station. This being immediately done, his worship instructed the police to ring the fire-bell, and summon the brigade to a "fire at Mr. Rooper's, Tillington." The fire-bell was accordingly rung and caused great excitement in the town, the people rushing in various directions where rumour assigned the locality of the "fire." The brigade (of whose members the captain and superintendent alone were in the secret) were speedily got together, in a remarkably short time an engine with two horses was pursuing its wild career to Tillington. The time occupied in reaching Mr. Rooper's house, and getting the engine ready for pumping from the first call was a little under 12 minutes. The brigade were heartily cheered for their smart turn-out by those present, and were entertained with refreshments after their hurried journey. In the meantime, various messages were sent through the telephone to all parts of the town, those present being much pleased with the great facilities for communication which the telephone system affords.

**The Telephone in America.**—The proportion between the number of telephone subscribers and the population, is, in the following towns:—Cincinnati, 1 in 88; Springfield, 1 in 59; Atlanta, 1 in 43; Chicago, 1 in 112; Boston, 1 in 170; New York, 1 in 175.

**New York Telephone System.**—The *Journal Télégraphique* of Berne states that a general system of telephonic communication is in the course of organisation in New York. It is proposed to work from one central station no less than 12,000 telephone lines. 10,000 of these will be for the use of subscribers, and 2,000 dedicated to the service of the system. If carried out this will be by far the largest telephone installation worked from a central station.

**Swinton's Telephones.**—The Equitable Telephone Association, Limited, is introducing a new instrument at a low price to meet the demand for a reliable telephone for use over short distances. Fig. 1 represents

FIG. 1.

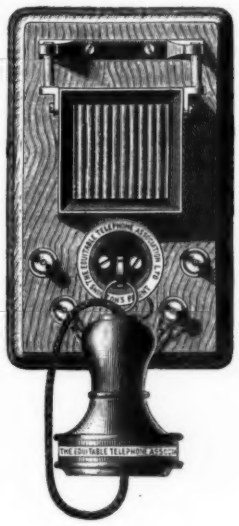


FIG. 2.

the apparatus with, and fig. 2 without the call bell. A third type is made in a portable form to stand on a writing table. Of course for long distances the more powerful type of Swinton telephone, such as was illustrated in the REVIEW for June 10th, is necessary.

**American Land Lines.**—The stockholders of the Western Union Telegraph Company have unanimously approved the contract entered into with the Baltimore and Ohio Railway for the lease of its telegraph system. The telegraph companies competing with the Western Union have come to an agreement with that company to advance their rates to the Western Union's tariff.

**Italian Telegraphs.**—The following data may be of interest:—

| Year. | Lengths of lines. | Lengths of Conductors. |
|---|---|---|
| 1884 | 29,188 klm. | 103,080 klm. |
| 1885 | 30,021 „ | 106,755 „ |
| 1886 | 30,573 „ | 108,908 „ (First six months.) |

The figures for 1886 include 22 submarine cables with a total length of 183·78 kilometres, and 1472·1 kilometres of cables through tunnels.

**Optical Telegraphy.**—A telegram from the *Times* correspondent in Brussels appeared in Monday's issue of that journal, and was to the following effect:—"Successful experiments in optical telegraphy, by means of the luminous captive balloon, have been made at the camp of military engineers, near Antwerp. Mr. Bruce, assisted by Mr. Queenston, prepared the apparatus, and Captain Mahauden directed the operations. The military authorities present were satisfied with the results, which are very creditable to the Electrical Power Storage Company."

**Cutting Telegraph Wires in Ireland.**—The police authorities have issued notices throughout West Clare, in reference to the cutting down of the telegraph wires between Kilrush and Ennis last week. In future where such outrages are attempted, a police hut will be erected on the scene of the occurrence, and the parish will be taxed with the cost of the constabulary stationed at the hut.

**Ceylon Telegraphs.**—The Postmaster-General and Director of Telegraphs in Ceylon has issued his report for the past year. The revenue amounted to 103,417.52 r., showing a decrease when compared with that of 1885, but this is accounted for by the fall in postage collections, representing collections on unpaid correspondence. The total expenditure of the department was 479,750.98 r. As regards the transmission of telegrams, the Indian system of charging different rates for "urgent," "ordinary," and "deferred" messages was introduced. The third change was in regard to the share credited to the Ceylon Administration of the receipts on account of foreign telegrams. Hitherto one-sixth had been credited; and, after some discussion, the Government of India agreed to give the Ceylon Administration one-fifth. The result of the change will be to add 7,000 r. to the receipts there.

**The Atlantic Cable Contest.**—According to the *Times*, Mr. Jay Gould, in a recent interview, said, with reference to the ocean cable business:—"Nobody is making money at the current rates. Under these circumstances it is naturally the interest and desire of all parties concerned to bring the conflict to as speedy a termination as possible. But there are so many cables that the situation is very complicated. I met Mr. Mackay personally last summer, and negotiations were conducted for some time, but without effecting the usual result, and finally the attempt to accommodate matters dropped. The Commercial Cable Company therefore reduced its rates to 12 c. I presume some agreement about cable rates will be ultimately arrived at, as it is not reasonable to suppose that the companies wish to continue indefinitely doing business at a loss. Mr. Mackay wishes to make a 40 c. rate, because he has pledged himself not to go above that, and has accompanied his pledge by a guarantee to refund certain moneys to his customers if he does. He did not estimate how large a sum was necessary to make this guarantee good. Then with regard to cable matters we are only members of a pool, and whatever we may want to do must be sanctioned and authorised by our associates."

**The Motive Force of the World.**—The Bureau of Statistics in Berlin has recently issued some interesting information in connection with this subject. Four-fifths of the engines now working in the world have been constructed during the last 25 years. France owns 49,590 stationary or locomotive boilers, 7,000 locomotives, and 1,850 boats' boilers; Germany has 59,000 boilers, 10,000 locomotives, and 1,700 ships' boilers; Austria 12,000 boilers and 2,800 locomotives. The force equivalent to the working steam-engines represents: in the United States, 7,500,000 horse-power, in England 7,000,000 horse-power, in Germany 4,500,000, in France 3,000,000, and in Austria 1,500,000. In these figures the motive power of the locomotives is not included, whose number in all the world amounts to 105,000, representing a total of 3,000,000 horse-power. Adding this amount to the other powers we obtain the total of 46,000,000 horse-power. A steam horse-power is equal to three actual horses' power; and a living horse is equal to seven men. The steam engines of the world represent, therefore, approximately the work of 1,000,000,000 men, or more than double the working population of the earth, whose total population amounts to 1,455,923,000 inhabitants. Steam has accordingly trebled man's working power, enabling him to economise his physical strength while attending to his intellectual development.

**South Australian Telegraphs.**—They are now celebrating the jubilee of the Colony of South Australia, and the *Colonies and India*, speaking on the matter, says telegraphy may well be associated with the jubilee, because its share in the progress that has been made is by no means small. Little more than thirty years have elapsed since the first telegraph line in the Colony was opened from Adelaide to the Port. This was constructed in 1856 by private enterprise, and was shortly afterwards purchased by the Government for £80 and pulled down. When the first Government line was opened between these points it seemed for a time as though it were an utter superfluity. The receipts for the first day were 5s. 3d., the second 2s. 6d., the third 1s. 9d., and the fourth 1s. 3d. From that unpromising beginning, however, steady progress was made. The next extension was to Gawler, then came the line to Melbourne in 1858, and the great work of traversing the continent, which began in 1870, was completed in less than two years. A line nearly 1,000 miles in length through most difficult country now connects the Colony with Western Australia.

**Lightning Statistics in Germany.**—We read in *La Lumière Electrique* that M. G. Hellmann has lately published the results of investigations made by him upon accidents due to lightning in Germany. It is stated that although, as a general rule, mishaps from this cause are increasing every year, a few notable exceptions have been remarked in certain parts of the empire, where disasters from lightning have diminished in a marked degree. It seems that lightning strikes churches 39 times, and windmills 52 times, more frequently than ordinary dwelling houses; and the chances of buildings being struck are five times greater in the country than in towns. In Berlin the fires caused by lightning only amount to 0·2 to 0·3 per cent. The report describes the various soils and trees which appear to be most subject to visitations from lightning. We are told that from 1869 to 1883 the proportion of persons killed by lightning was:—

| | | |
|---|---|---|
| In Prussia ... ... ... | 4·4 | per million inhabitants. |
| „ Grand Duchy of Baden ... | 3·8 | „ „ |
| „ France ... ... ... | 3·1 | „ „ |
| „ Sweden ... ... ... | 3·0 | „ „ |

**The Gale and the Wires.**—A destructive storm raged throughout almost the whole of the United Kingdom on Monday night, and in many districts telegraphic communication was either wholly or partially stopped. In North Wales and in Lancashire the most serious effects of the storm seem to have been felt, so far as the telegraphs are concerned.

**Lightning Fatalities.**—During the storm on Sunday night, at Carahboge, between Killorglin and Glenbeigh, a farmer named Walsh was tying a cow in a shed, his eldest son standing some yards off, when a flash of lightning came and the two men and the cow were struck dead.

**Personal.**—Mr. C. N. Russell, formerly foreman to Messrs. Goolden & Co., of Westminster, has now accepted the post of electrician to Mr. Ronald A. Scott.

We understand that Mr. Samuel Vyle has been appointed electrician to the Post Office of British Guiana, with charge of the Government land lines and cables. From our knowledge of Mr. Vyle we are sure he will do all that is in the power of mortal man to give satisfaction, and we congratulate him on his appointment.

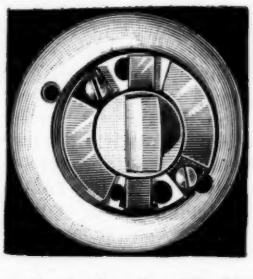
The old friends and acquaintances both here and abroad of Mr. Basil Gee, the electrician to Callender's Company, are doubtless mindful of his woman-hating proclivities, and it will come therefore as a surprise to many that he has fallen a victim to the tender passion, and that on the 14th ult. he renounced the freedom of bachelordom for the restraints of connubial bliss. He has our cordial wishes for his future happiness.

We are pleased to notify that Mr. J. Swinburne returned to London on Wednesday last, his American trip having lasted seven weeks. Our readers may now look forward to a resumption of his articles on practical electrical measurement.

**Society of Engineers.**—At the ordinary meeting of this society to be held next Monday at the Westminster Town Hall, a paper will be read on "Primary batteries for illuminating purposes," by Mr. Perry F. Nursey, Past President, of which the following is a synopsis: Introduction. A wide field open for primary batteries. Their principles and history outlined. Descriptions of batteries for special purposes, and batteries for general lighting, including those of Holmes & Burke, Ross, Coad, Lalande, Skrivanow, Upward, Pollak, Newton, D'Humy, and Friedlaender; and the "Regent," the "Union," and the "Eclipse" batteries. Conclusions. Several of these batteries will be exhibited at the meeting, and glow lamps will be driven by them.

**Lightning Conductors.**—We learn that Vyle's patent lightning conductors are being placed all over the New Municipal Halls at Middlesbro' by Messrs. Cox-Walker and Co.

**China Switches.**—Messrs. Fowler, Lancaster & Co. have forwarded us samples of their new forms of switches in china covers, which are manufactured in four forms, namely, cross bars or double break, single



break with fuse, single break with fuse and with no metallic parts projecting from the back, and double pole. Messrs. Fowler & Lancaster also make wall connectors, lampholders, and fuses of the same material, and are using them in installations which they are carrying out.

**Electric Traction in Brussels.**—During the last few days, says the Brussels correspondent of *Industries*, a new electric tram car has been put on the line of the Boulevard, which, as reported before, is worked on the Julien system. The new car, which has three axles, is much larger than the usual type, and contains room for 60 passengers. Its maximum speed is 15 miles an hour, and it is adapted for heavy gradients. The car is intended for Australia, and the object of putting it on the line is simply to give it a thorough test before sending it off. I have already reported that the motors employed on the electric tram cars are somewhat defective, and one of these cars has been re-fitted with an English made motor by way of experiment. The substitution of this motor has practically doubled the capacity of the car, enabling it to make 25 journeys with one charge, whereas previously only 13 journeys could be made without changing batteries. The only disadvantage of the English motor and gear is the great noise produced.

**Gas Explosion.**—A serious gas explosion occurred on Monday night at 11, Albert Embankment. A strong escape of gas was detected, and while five people were in the house the foolhardy practice of attempting to trace the leakage with a light was resorted to. The result was a terrific explosion, which wrecked the house of eight rooms and the contents, and severely burnt several people, who were removed to St. Thomas's Hospital.

**Electrical Treatment for "the Morphine Habit."**—According to American newspapers, Dr. Oscar Jennings, who is electrical physician to the Clinic of St. Anne, in Paris, has just left New York with the satisfaction of having given New York physicians a clear idea of his new theory and practice of curing the morphine habit. Dr. Jennings is the Paris correspondent of the *Lancet*.

**Hughes's Induction Balance.**—Writing to *Nature* from the Central College, Bangalore, S. India, Mr. J. Cook says:—"Having just made a Hughes's induction balance, I have, in the course of some experiments with it, observed what was new to me, for I have not seen it mentioned in any account of the balance. I take the liberty, therefore, of asking through your columns whether the explanation resolves itself into the difference between paramagnetic and diamagnetic substances. The apertures of my bobbins are 1½ inch in diameter; my primary current is from three Daniell's, and the break is a bent steel spring whose free point just grazes the surface of a mercury cup, so that the merest touch with a finger causes a series of regular breaks. Now, if I place an iron or steel disc, or ring, such as a key-ring, inside the aperture, the telephone sounds loudly if the plane of the disc or ring is at *right angles* to the plane of the coils; but very very faintly if it is *parallel* to the plane of the coils. On the other hand, if a disc, or ring, or coil of wire, of any of the diamagnetic metals—copper, brass, zinc, silver, gold, aluminium, lead—be used, the telephone sounds loudly if the plane of the disk or ring be *parallel* to the plane of the coils; but very faintly, if at all, when it is perpendicular to the plane of the coils. Further, if a short *bar* of soft iron, or of nickel, be inserted so that the length of the bar is parallel to the plane of the coils, almost no sound is heard; but if it be turned through a right angle so as to be perpendicular to the plane of the coils, the sound is a maximum. Have we in this simple instrument the ready means of distinguishing paramagnetic from diamagnetic substances?"

**Electrical Tramways.**—During the forthcoming session of the Institution of Civil Engineers, a paper, with a view to discussion, will be read by Dr. Edward Hopkinson, on the Bessbrook and Newry tramway.

**Edison's Phonograph.**—The *Musical Times* says:—"That modern miracle worker, Mr. Edison, is 'at it again.' Having got the electric light out of hand, his restless inventiveness has taken up once more with what most of us had come to regard as a discarded toy—the phonograph. The instrument became a nine-day's wonder, and then was practically forgotten. But it remained present to the mind of the inventor, who now claims to have made it a thing of commercial value. Will singers and instrumentalists sing and play into the 'receiver,' and scatter examples of their skill all over the globe to order? Will Rubinstein or little Hofmann make a tour of the world by phonogram, sitting quietly at home and preparing new specimens, while agents travel about displaying them? Shall we have shops for the sale of Albani, Patey, Lloyd, and Santley phonograms? May we hope—but a truce to questions which the reader can ask for himself in any number. Lucky artists of the future, if the phonogram becomes fashionable!"

**Electricity in the Royal Navy.**—The harbour of Corfu has recently been the scene of some interesting submarine mining operations. The *Colossus* and *Hecla*, belonging to the Mediterranean Squadron, laid down observation mines across the mouth of the port. The *Colossus* had her anchor down and her stern hauled close to the eastern shore, so as to enable an electric cable to be carried from her to one of her powerful search lights which had been landed and erected on the cliffs. On the opposite side of the harbour the *Hecla* was similarly secured. As soon as war was declared, the remainder of the Mediterranean Squadron hove in sight and commenced the attack, which was maintained with great vigour, several craft on either side being ruled out of action by the umpires.

Orders have been received at Chatham Dockyard directing the new cruisers *Narcissus* and *Australia* to be each fitted with three electric search lights and two yard arm lamps, and to be supplied throughout with an approved electrical system, similar to that at present in use on board H.M.S. *Warspite*.

**A New Helio-Telegraph.**—Lieut. John P. Findlay, Assistant Chief Signal Officer in the United States Army, has been superintending the completion and testing of a new helio-telegraph instrument of which he is the inventor. The machine is applicable to any code. It consists of a double mirror by day, or two powerful lights by night, arranged at the ends of a bar. The flashes are made by keys and levers, a dot being sent by a single light, and a dash by two lights combined. The instrument combines the telescope level and signalling apparatus in one, instead of the separate instruments hitherto in use.

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**Liquid Metallic Enamels.**—Protected by the registered trade mark of "Ardenbrite," a metallic liquid has been recently invented which, though it is applied in the same manner as an ordinary coat of paint or varnish, imparts to the surface of any material upon which it is used the appearance of being gilt, silvered or bronzed, according to the kind applied. It dries in half-an-hour, and is then permanent and washable, and it can be put on either over paint or varnish or direct on the bare unprepared material. A distinct preparation are the Ardenbrite enamel paints, which produce with two coats a surface like China in appearance, and are found to be very suitable for every kind of decorative work in public offices, hotels, houses, ships' cabins and railway saloons. We call attention to these enamels and paints, because in connection with electric lighting and other operations there must be many occasions when one or other of such preparations as these would be just the very thing wanted to give an artistic and decorative finish to work which might otherwise be somewhat unsightly. Descriptive lists can be obtained of Messrs. Pavitt and Sons, 70, Southampton Row, London, W.C.

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**Notes from Turin.**—Under this heading a correspondent of the *Contract Journal* writes: "The electric lighting is not so general or systematic as at Milan; but there are a great many Siemens arc lamps of 2,000 candle-power, and several 50-candle incandescent lamps, supplied by the Cruto Company, in the arcades, and placed alternately with and superseding the gas lanterns. Many hotels, cafés, and public institutions are also lighted electrically by incandescent lamps. Situated almost at the foot of the Alps, Turin is subject to heavy and long-continued falls of snow, and the following simple but effectual method is employed for clearing the telegraph and telephone wires, so as to prevent them yielding to the superincumbent weight where any considerable length is unsupported—Vertical wires, sliding with a loop along the conductors, depend from them, being united by a ball some distance below, but still well above the vehicles in the streets. The conductors are kept clear of any considerable quantity of snow by simply moving the vertical wires along them by means of poles."

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**The Missing Link.**—An associated press dispatch from Bridgeport, Conn., dated September 5th, reads as follows:—"A submarine cable, measuring about 2,500 feet was fished out of the lower harbour this morning by Captain Green, of the steamer *Isis*, and brought to this city. Where it came from, or how long it has been where found, is a mystery. Harbour Master McNeil, who is an old Sound captain, and other salts, think some tug or heavily laden coal barge, having a broken nose or a projecting spike in her keel picked it up at Throgg's Neck, or in New York Bay, broke it from its shore fastenings and brought it here. The cable is composed of seven copper wires encased in rubber, surrounded by 10 galvanised iron wires, the whole covered with hempen cord, tarred. It had evidently been in the water 15 or 20 years. I believe these cables are often carried away in the North River, New York, by ocean steamers." Cables seems plentiful over there. Fancy our Isle of Wight cable being walked off with, and never so much as missed!

**Electric Motors.**—We predict, says the *Electrical Review* of New York, that the time is not far distant when there will not be found a steam engine under 10 horse-power in the manufacturing shops within reach of the generating stations of the electric light companies. Electric motors will be the source of power, and the lighting companies cannot spend their spare energies to better purpose than in encouraging the rental of motors to the utmost extent. Let any company calculate the receipts on investment if their full generating capacity can be utilised thus during the greater part of the 24 hours, and they will find enough incentive to push the matter vigorously.

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**Photographing Extraordinary.**—Only a short time ago, says our New York contemporary, we had wonderful accounts of photographing cats and things on somebody by lightning. Lightning will have to hurry if it gets much ahead of the electric light. A night dynamo man, so the story goes, was very intimately acquainted with two ladies, one of whom is his wife. The latter saw him mostly at home—the former didn't. One night not long ago, when it rained, and the lines were heavily grounded, the other lady dropped in at the station, and on account of the rain stayed longer than was her custom. Just before she departed, passing near the dynamo, she came in contact with the electric machinery in some way, and received a terrible shock, from which her friend rescued her, he also being considerably injured by the current. The dynamo man thought no more of it until the next morning, when his wife called him to breakfast, and showed him a fine photograph of number two, which had fallen out of his coat pocket. The picture had been done by the current at the instant he rescued his friend from her perilous position. This was the dynamo man's explanation of the phenomena.

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## NEW COMPANIES REGISTERED.

**Clamond Incandescent Gas Light Company, Limited.**—Capital: £200,000 in £1 shares. Objects: To carry on in all branches the business of a gas electric lighting and power company, and particularly to purchase from R. T. Haws and Wm. Thomson the patent rights of the "Clamond incandescent burner." Signatories (with one share each): E. T. Read, 80, Lombard Street; E. P. Rogers, 37, Walbrook; E. H. Chandler, Watford; R. M. Haws, Kenley, Surrey; W. A. Turner, 76, Coleman Street; W. Scotland, Richmond; R. A. Hoffman, 14, Haverstock Street, Islington. Directors' qualification: £200 in shares. Remuneration: £200 per annum to each director, with an additional £100 per annum to the chairman. Registered 29th ult. by Frederick Foss and Ledsam, 3, Abchurch Lane.

**Extended Electro Metal Extracting, Refining, and Plating Company, Limited.**—Capital: £150,000 in £1 shares. Objects: To acquire and work the business, patents, assets, and goodwill of the Electro Metal Extracting, Refining, and Plating Company, Limited, carrying on the business of extracting and refining metal by the electro process, and of galvanising and plating iron and other metal goods by electrolysis and otherwise. Signatories (with one share each): A. Salmon, 26, Herbert Street, Hoxton; T. Fenwick, Hutchings Street, Millwall; T. Bradfield, T. H. Salmon, Stowmarket; S. J. Hewlett, 18, Pomona Terrace, Fulham; S. J. Boyce, 2, Metal Exchange Buildings; S. H. Pyke, 138, New Bond Street. The signatories are to appoint the first directors, themselves acting *ad interim*. Remuneration: £600 per annum, or such larger sum as may be equal to 10 per cent. per annum of the net profits, but not exceeding £2,000 in any year. Registered 31st ult. by Pyke and Minchin, of 2, Metal Exchange Buildings, E.C.

**Opperman Electric Lighting and Manufacturing Company, Limited.**—Capital: £20,000 in £5 shares. Objects: To purchase the business of Mr. Carl T. J. Opperman, trading as Laurence Opperman at the Crown Works, Amhurst Road, Hackney, and to carry on the business of an electric light company in all branches. Signatories (with one share each): *Lord E. Spencer Churchill, Moreton in the Marsh; *A. W. Hall, M.P., S. Thomas, Oxford; *Rev. H. Barter, Shipton, Oxon; H. M. Spencer, Moreton in the Marsh; C. Barter (electrical engineer), Shipton-under-Wychwood; H. N. Warburton (electrical engineer), Winchester; C. J. Opperman (electrical engineer), Crown Works, Hackney. The signatories denoted by an asterisk are the first directors. Qualification: £25 in shares. Remuneration; £100 per annum. Registered 1st inst. by Warren, Gardner and Murton, 45, Bloomsbury Square.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Medical Electric Belt, Truss and Health Appliance Company, Limited.**—An agreement, dated 31st ult., provides for the allotment of 50 fully paid shares to Mr. Robert Henry Thomas, of 58, New Bond Street, in pursuance of an agreement of 26th March, under which Mr. Thomas was appointed joint manager of the company with Mr. Frederick Wood.

**Hastings and St. Leonard's-on-Sea Electric Light Company, Limited.**—The registered office of this company is removed to the company's works, Earl Street, Hastings.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Hammond Electric Light and Power Supply Company, Limited. (In Liquidation.)

MR. WILLIAM THEOBALD, the liquidator, presided on Thursday last week at Winchester House over a meeting which he had convened of shareholders in this company.

The notice convening the meeting having been read,

The Chairman said: Before going to the report, I must refer to the circular which was issued in April last, and which stated that we should probably call a meeting in the following June. Soon after that circular was issued I found, on looking into the matters outstanding, that they were so few and of such little value that if I deferred calling the shareholders together for a little while, I should be able to place before you the final accounts, and that I am able to do to-day. I have the pleasure of presenting the following report upon my duties as liquidator, which I venture to think will reveal a more satisfactory result than was at one time anticipated. On June 10th, 1885, I was appointed by the Chancery Division of the High Court of Justice provisional liquidator of your company, with power to carry on the business, so far as was necessary for carrying out and completing existing contracts, and to pay wages and other charges. On the 17th of the same month, at an extraordinary general meeting of the members it was resolved that the company should be wound up voluntarily, and I was appointed liquidator. The following shareholders were at the same time appointed a consulting and advising committee, viz.:—Messrs. E. H. Brown, A. M'Alister, and F. W. Reynolds. Immediately on taking possession of the assets and undertakings of the company, including as they did important uncompleted contracts, it became apparent that many of them were of a very special character, their advantageous realisation demanding personal and most careful consideration, and I have to acknowledge the valuable assistance which was afforded me at this time by the advising committee. Valuable assistance was also rendered from time to time throughout the proceedings by Mr. Robert Hammond, which has been of substantial service to the liquidation. A lighting station at Brighton had been worked for some time, but was in a very incomplete state, and under the conditions of the lease certain of the engines used for driving the dynamos had to be removed. Although there seemed every probability that by expenditure of additional capital the lighting station might be placed on a profitable basis, it was doubtful if at that time it was paying expenses. A contract for management for a term of years had been entered into with the Eastbourne Electric Light Company, Limited, under which the Hammond Company was to bear all losses or take the profits, if any, on the working; they were also to provide the requisite capital for extension purposes, and to receive payment in debentures of the Eastbourne Company. A similar contract had also been entered into with the Hastings and St. Leonards-on-Sea Electric Light Company, Limited. Under the two last-mentioned contracts the Hammond Company had become entitled to debentures of the Eastbourne Company for about £7,050, and of the Hastings and St. Leonards Company for about £3,300. In the case of the Eastbourne Company the debentures, jointly with others to the extent of £500, formed a first charge upon the assets of the company; but in the case of the Hastings Company the debentures only ranked after a charge for £4,000 given to the bankers. Neither of the above companies was paying expenses; and after careful consideration it was decided to risk the refusal of supplies to the Hastings Company (fortunately without causing a stoppage of its business), but to carry on the Eastbourne contract for a time in the hope of obtaining a purchaser for the debentures, who would also undertake to perform the contract. With this object in view the liquidator made overtures to the Anglo-American Brush, the Edison & Swan, and other electric light companies. Protracted negotiations and correspondence also were carried on with the representatives of all the various interests concerned, but without satisfactory result; and after long and tedious efforts to sell by private treaty it was determined to offer for sale by public tender not only the Brighton lighting station, the Hammond Company's interest in the Hastings and St. Leonards-on-Sea Electric Light Company and the Eastbourne Electric Light Company, but also what remained of the hiring installations in other parts of the country. Advantage was taken of the issue of a circular by the Consulting Committee on September 16th, 1885, to forward a copy of the advertisement of this sale to every shareholder on the register. Offers were received for each of the properties mentioned, some of which were immediately accepted, but in other instances improved prices were obtained by subsequent negotiations. The issue of the tender forms and the acceptance of each offer were made with the approval and under the direction of the court. I found it impossible to arrange any scheme for the reconstruction of the company; and as enquiries are still occasionally made on the subject, I cannot do better than quote from the circular of the committee above referred to, in which they say:—"Since you appointed us to confer with your liquidator, we have carefully considered the possibility of a resuscitation of your company, and we regret that we are unable to recommend such a course. The large amount of liabilities and claims, about £20,000, and the peculiar nature of the assets, would necessitate an immediate subscription of considerable capital, which we do not feel justified in asking the shareholders to find." They added:—"We fear the prospect of any return being made to the shareholders is extremely doubtful." Since issuing this circular in September, 1885, the committee have taken no part in the management of the liquidation, feeling that the shareholders were not likely to obtain any benefit from their labours, and having at the meeting convened by the above circular resigned their position. Another of the undertakings in connection with, and, in fact, forming part of the Hammond Company, which at one time seemed likely to involve many troublesome claims for uncompleted contracts, was the Electrical College in Red Lion Square. All the claims from the parents and guardians of the students, which at one time seemed inevitable, were avoided. Not one claim was sustained, and I believe general satisfaction was given. In conducting the liquidation it was often difficult to decide how far it was advisable to carry out contracts for work on hand and hiring contracts, and whether less loss would be incurred by breach of the contract than by completing it. The labour of realising the estate and in settling the claims has been much heavier than was at first anticipated. It is a source of pleasure to me, therefore, to be able to report that, whereas at one time it seemed doubtful if even the creditors would be paid in full, I am able to report to-day that they have all been paid, and it is proposed to make a return of 3s. per share to the shareholders. When the property came into the hands of the liquidator a large amount of the stock was in an unfinished condition. After careful consideration it was determined to complete as many dynamos as possible before offering them for sale. Several offers were received for part of the plant and stock by private treaty, but the difficulty of fixing prices being considerable, and some of the offers received being absurdly small, it was decided, with the full concurrence of the committee, that all should be offered by public auction, excepting sales at current prices. In accordance with that decision, the whole of the plant, stock, and apparatus at the factory in Appold Street, at the stores in Bermondsey Street, at the lamp factory in Bermondsey, and at the Electrical College in Red Lion Square, were offered for sale at public auction, the sale occupying seven days. The amount realised, after deducting the heavy expenses and the auctioneer's charges, was £11,604 4s. The wisdom of the policy adopted, and of making so much of the sale as was done by extended advertising, was then fully manifested. The Anglo-American Brush Company's concessions and the Ferranti patents were offered at the auction sale, but no bids were made. Sales, however, have been effected subsequently at low prices. Under an agreement with Messrs. Donnithorne and Liardet, £5,695 had been deposited with Messrs. Hoare, the bankers, as a guarantee fund in connection with a contract. Early in August, 1885, the action between the company and Messrs. Donnithorne and Liardet was dismissed with costs, and the deposit, with interest, amounting in all to £6,099 13s. 9d., was ordered to be paid to me as liquidator. This was received on November 19th, 1885. In addition to the ordinary creditors for goods, &c., various claims arose out of royalty and other contracts; also heavy claims and complications arose in connection with the various leases held by the company. I was enabled

to settle all of these claims on favourable terms, and to get the company relieved of the claims on the leases. The claims of the debenture holders, which were carrying interest at the rate of 7 per cent. per annum, were discharged under an order of the court in January, 1886, thus stopping interest at that early date. The list of the other creditors having been settled by the court, notice of payment in full was given in May, 1886, and all have been discharged. The provisional cash statement herewith presented exhibits the amount obtained for the various properties of the company in a summary form only, but I shall be happy to supply such details as the shareholders may desire. The result of the liquidation shows that after paying the debenture holders and creditors' claims, amounting to £15,246, there remains a balance in hand of £8,583. There are, however, a few paper assets still to be dealt with before the liquidation can be finally closed. In conclusion, it only remains for me to remind you that when I was first appointed it was not expected that the work of the liquidation would have entailed such unremitting and personal labour, or that it would turn out so favourably to the shareholders as it has done. In view of this, your liquidator was induced to accept a fee of 600 guineas. The result of the liquidation, however, entitles him, according to the scale fixed by the Court of Chancery, to a much higher rate of remuneration, which would, no doubt, be allowed upon application to the court, but it would be some satisfaction to the liquidator if the meeting were to pass a resolution which would certify their appreciation of his services. It is upon the official basis of remuneration, as allowed by the court, that the accounts now about to be laid before the meeting are made out, showing a balance of £8,583 10s. 11d., and the liquidator proposes forthwith to make a return to the shareholders of 3s. per share, which will absorb £8,401 1s., and thus practically close the liquidation.

Mr. Ince commended Mr. Theobald for the manner in which he had carried out the liquidation, and proposed a resolution, increasing the remuneration of Mr. Theobald to 900 guineas, on the condition that 3s. a share was returned to the shareholders.

Mr. A. M'Alister said that the meeting must first deal with the report and accounts.

Mr. Ince said that in point of order Mr. M'Alister was right, and he would therefore propose the following resolution first:—"Resolved that the report of the liquidator and the accounts of the liquidation be, and the same are hereby, received and adopted, and that, in view of the liquidator's report, this meeting is of opinion that the whole of the outstanding assets are irrecoverable and valueless, with the exception of the iron safe and office furniture, and that the liquidator be, and he is hereby, instructed to refrain from any further effort, and from incurring any further expense in connection with attempts to dispose of such outstanding assets, and that upon the completion of the winding up the said iron safe be retained by the liquidator for the purpose of preserving until such time as the Court sees fit the books and documents of the company."

Mr. A. M'Alister seconded the resolutions.

Mr. F. W. Reynolds said that the committee had found that it would be hopeless under the circumstances to reconstruct the company, which possibly came into existence rather too soon.

The Chairman, in reply to a question, said that the money was all in hand, and he proposed to distribute it as soon as the circular could be sent out.

The resolutions were unanimously agreed to, the meeting thereupon terminating.

## Brazilian Submarine Telegraph Company, Limited.

THE twenty-eighth ordinary general meeting of this company was held at Winchester House, Old Broad Street, on Wednesday, the Right Hon. Viscount Monck, chairman of the company, presiding.

Mr. Richard Collett, the secretary, having read the notice convening the meeting, and the minutes of the previous meeting, which were confirmed,

The Chairman said he presumed the shareholders would take the report (which appeared in the REVIEW last week) as read. Receiving an affirmative assurance, he proceeded: I have now to move the usual resolution upon the report, and in doing so I shall not have to trouble you at any considerable length, for I think you will all be satisfied with the practical results shown in the report. I remember on one occasion hearing Mr. Gladstone say in the House of Commons, when he was obliged to refer to a speech which he had formerly made, that next to eating one's words the most disagreeable thing was quoting them. That I think depends very much upon the effect or meaning of the quotation, and if I refer to what I said last year, I must say my unwillingness to do so is very much qualified by the nature of the comparison I can make with the speech I made then. On that occasion I had to condole with you on a diminution in our receipts. I told you that the depression of trade which had effected all the rest of the world more or less had at last reached us, and that we were suffering from it, our receipts being very much less than they were the year before. I am glad to be able to say that that need not be the tone of my address on this occasion. We have had during the half year to which this report refers the largest receipts we have ever had since the company was started. Our receipts for the half year ending June 30th are over £100,000. They have enabled us to declare for you the usual dividend of 6 per cent., and also a bonus, which brings the annual dividend of the company to 7 per cent. for this year. This is a subject for congratulation to your directors, as showing the prosperous condition of the undertaking. I am happy to inform you that the increase in the receipts of the company has gone on, and we are now in pretty much the same condition in reference to the receipts as we were at this time last year—I mean for the three months from June to October. I hope that we shall be able next year to meet you with as satisfactory a statement and to declare as good a dividend. The report states in very plain language all that I could tell you if I stood here for the next half hour. The plant of the company is in good order. We have increased our reserve fund, which now amounts to £112,000, by the sum of £25,000 this half year, and the expenditure shows a small increase of £326, but that is accounted for in a very great measure by the increased traffic, and also by the fact which I alluded to at the last meeting, that we have had to meet attempts at creating competition, efforts which could not be made without a certain expenditure of money. I have had a letter from one shareholder asking me to say something about the African Direct Telegraph Company, in which we are interested to a considerable extent. Now, I may say in general terms, that that company has been in operation but a very short time, but the receipts are improving, and it now about pays its expenses. Therefore we may hope that it will, after a little while, become a source of profit to us. But I must at the same time remind the shareholders that when we embarked in that company we did it very much as a matter of strategy, and not as a pecuniary speculation. We did not want to get a rival into our own district, so to speak, and upon that ground as much as any other we took up that company. When at the special meeting I suggested that you should take an interest in the company, I told you this fact, and the shareholders were perfectly aware of the reasons which induced the directors to take the part they did in the formation of that company. However, the receipts are improving, and I hope that in the course of time it will become a source of profit to us. I do not know that there is any other subject upon which I need address you, and therefore I will move: "That the report of the directors and the accounts to June 30th, 1887, now submitted be approved and adopted, and that a dividend be now declared of 3s. per share, making, with the dividends already paid, a total of 6 per cent. for the year ending June 30th, and also a bonus of 2s. per share, the said dividend and bonus to be respectively free of income tax."

Sir James Anderson seconded the resolution.

Mr. Newman said before the resolution was put to the shareholders he wished to repeat a statement he had always made from the beginning, that he considered it a short-sighted policy not to add as much as possible to the reserve fund. There were only six years left of their term of 20 years, and they might depend upon it that where a company had been so invariably successful from the beginning, their receipts increasing yearly, there would be opposition. Another cable would be laid down, and opposition would mean a fight between the two companies at a great expense and loss to the shareholders. He thought it would be very much better if the 2s. per share which it was now proposed to divide were put to the reserve fund.

The Chairman said it was quite refreshing to him as a chairman to have such an observation made as that which had come from Mr. Newman. He had been always fighting the cause of a large reserve fund, and had brought upon himself upon more than one occasion very sharp observations for doing so; but in this case he did not think they were unduly neglecting the reserve fund. He thought Mr. Newman must have forgotten for the moment that they had already duplicated the whole of their system by means of the accumulation of a reserve fund, with the exception of a very small portion. The reserve fund now stood at £112,000, and he did not think they would be justified in withholding from the shareholders what they had legitimately earned during the half-year.

The resolution was then put and carried without dissent.

Sir James Anderson and the Hon. W. St. John F. Brodrick, M.P., were re-elected directors, and the auditors, Mr. Henry Dever and Mr. John Gane were also re-appointed, the meeting thereupon terminating with a vote of thanks to the chairman and directors.

## Woodhouse and Rawson, Limited.

THE statutory meeting of the shareholders in this company was held on Wednesday, at 20, Bucklersbury, E.C., under the presidency of Sir John Stokes.

Mr. J. Shurmur, the Secretary, having read the notice convening the meeting,

The Chairman said: This is merely the statutory meeting and there is no formal business to put before you. One or two points you may be interested to hear. Mr. Ashby, who represents a large number of shareholders, has joined the board. I regret to tell you of the death of Mr. Woodhouse. This took place on September 21st, after a long illness. It is two years since Mr. Woodhouse attended to the business, so his decease will make no difference in the conduct of it. The directors wish to express their regret at Mr. Woodhouse's death. Those are the only intimations I have to make to you.

Mr. George Smith said shareholders would like to hear how the company was getting on, whether all the shares were taken up, whether the work was progressing satisfactorily, and whether they might look forward to receiving in due course their 10 per cent. dividend. Any information which could be given would be very acceptable to the shareholders.

The Chairman said they hoped to carry out the purposes of the

company as announced in the prospectus. They had already business on hand which justified them in hoping that they would be able to declare a dividend when the time came; but this was an early hour to say whether or not there would be a dividend of 10 per cent., or what it would be.

Mr. Smith: I think it is stated in the prospectus.

The Chairman: Oh, of course! Continuing, he said there had been a great increase latterly in the demand for electrical supplies—an increase, that was to say upon the work done by the firm from whom they had taken the business. Arrangements were being made by which their lamps might be made abroad and sold upon profitable terms; this would materially improve the position of the manufacturing company in which this company was largely interested, and which had obtained the sole right to manufacture for two companies from whom they were receiving large orders.

Mr. Smith: I suppose the litigation is at an end.

The Chairman: We are in no litigation at all.

Mr. Smith: Woodhouse and Rawson are.

The Chairman: Yes; but we are not concerned in that.

Mr. F. L. Rawson rose to explain. The litigation was at an end, except that they had the right to appeal to the House of Lords for some length of time, but, of course, it depended upon how matters went during the next few months whether they would appeal or not. But this had nothing to do with Woodhouse and Rawson, Limited; it concerned Woodhouse and Rawson only.

Mr. Smith: It would be of very great moment if the company can make the lamps in this country. You are going to make them abroad, I understand?

Mr. Rawson: Yes; no doubt.

Mr. Smith enquired whether the meetings would be held half-yearly or not, and was informed that they would be annual, the next to take place in October of next year.

The meeting then terminated.

## TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of October was 3,416, estimated to produce £2,900, against 2,782 messages, producing £2,413 in the corresponding month of last year. The receipts for the month of July, estimated at £2,600, realised £2,607.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 28th were £3,362, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st October are £2,742, as compared with £2,633 in the corresponding period of 1886.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for October amounted to £40,018, and to £37,185 for October, 1886; increase £2,833.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of October were £2,276, against £2,058 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for October amounted to £33,089, and to £49,374 inthe corresponding month of 1886.

## NEW PATENTS—1887.

14204. "Contact and binding devices for electrical apparatus." J. R. HARD, T. WILSON. Dated October 19. (*Complete.*)

14209. "Electrical apparatus for prevention of corrosion or incrustation in steam boilers." W. H. RUSDEN. Dated October 19. (*Complete.*)

14212. "Electrolysis of aqueous solutions." A. S. ELMORE. Dated October 19.

14226. "Measuring electric currents, or electrical counter." N. J. R. JACQUEMIER. Dated October 19.

14241. "Machinery for telegraphic purposes." W. H. WATKINSON. Dated October 20.

14259. "Applying primary batteries for electric signals, telephones, lights, &c." C. HALL, H. BINKO. Dated October 20.

14260. "Preventing induction in electrical conductors." S. C. DREW. Dated October 20. (*Complete.*)

14262. "Mouth-pieces or adjuncts to telephones and other speaking instruments to increase the volume of sound." T. B. GARNETT. Dated October 20.

14270. "Producing sheet copper by electro-deposition." B. J. B. MILLS. (Communicated by E. Emerson.) Dated October 20.

14273. "Separating the plates of secondary batteries." A. J. LITTLETON. Dated October 20.

14288. "Incombustible batten to be used in connection with electric lighting of theatres." E. L. BERRY. Dated October 20.

14322. "Covering of electrical wires." A. W. SLATER. Dated October 21.

14329. "Electrical contact makers and breakers." E. PRICE. Dated October 21.

14346. "Bell pull electric light switch." A. P. LUNDBERG. Dated October 21.

14390. "Electric fire fuze or primer." R. MORRIS. Dated October 22.

14416. "Telephonic apparatus." J. L. CORBETT. Dated October 24.

14426. "Producing voltaic electricity by means of a cell, of which the positive element consists of an amalgam of either sodium or potassium, or of both." Sir C. S. FORBES. Dated October 24.

14445. "Insulating submarine telegraph cables." R. HADDAN. (Communicated by E. G. Prillwitz.) Dated October 24.

14461. "Electrical accumulators or secondary batteries." A. STETSON. Dated October 24.

14493. "Electric motors." L. HAPPE, G. HAPPE. Dated October 25.

14509. "Measuring temperature on the absolute scale by means of change of electrical resistance." H. L. CALLENDAR. Dated October 25.

14528. "Microphones." C. BELL. (Communicated by L. M. Ericsson. Dated October 25.

14529. "Microphones." C. BELL. (Communicated by L. M. Ericsson. Dated October 25.

14542. "Electric motors for tramway vehicles, &c." W. D. SANDWELL. Dated October 25.

14553. "Insulating supports for electric wires and rods." R. B. LEE. Dated October 26.

14561. "Switches for use in electric circuits." A. C. COCKBURN, E. THOMAS. Dated October 26.

14622. "Electric accumulator." E. C. VAUGHTON. Dated October 27.

14632. "Electrically lighting railway trains." T. A. TIMMIS. Dated October 27.

14647. "Electro-deposition of silver and nickel upon iron, steel, &c." H. H. LAKE. (Communicated by A. Breden.) Dated October 27.

14658. "Electric indicators." G. E. FLETCHER. Dated October 28.

14729. "Meter for measuring electric currents." W. H. DOUGLAS. Dated October 29.

14768. "Electric switches." C. M. DORMAN, R. A. SMITH. Dated October 31.

14771. "Electric switch." C. E. KNOWLES. Dated October 31.

14774. "Electrical attractor." G. B. WILKES. Dated October 31.

14807. "Combination of a fluid pressure vibrating motor with a dynamo-electric machine." G. M. CAPEL, J. G. RAWORTH. Dated October 31.

14834. "Regulating steam, &c., motors for working dynamo-electric machines or electric generators." W. R. LAKE. (Communicated by C. L. R. E. Menges.) Dated October 31.

14893. "Generation of electricity." L. G. WOOLLEY. Dated November 1. (*Complete.*)

14894. "Transformers and similar electrical apparatus." J. M. V. MONEY-KENT, S. SHARP. Dated November 1.

14901. "Electric batteries." C. R. GOODWIN. Dated November 2. (*Complete.*)

14924. "Electrical instrument for recording variations in speeds of engines, shafting, &c. E. E. WIGZELL. Dated November 2.

14954. "Apparatus to be used in the deposition or treatment of metals by the electrolytic process." W. TERRILL. Dated November 2.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

11239. "An improved arrangement of electric battery with means for regulating the amount of submersion or withdrawal of the positive plates." H. CARTER. Dated September 3. 8d. Claims:—1. The improved arrangement of electric battery provided with a movable platform carrying the connections and the positive plates, the platform being supported above the battery and maintained at any desired height by a set screw, in the manner described and shown in the drawings. 2. Fixing short carbon plates to the inner faces of battery cells, as set forth and as shown, for allowing the negative electrodes to be attacked in an uniform and regular manner. 3. Perforating or making three centrally formed apertures in the zinc or negative electrodes as shown, to facilitate the passage of the exciting liquid and to diminish polarisation, the zinc being kept clean by free oxfoliation. 4. The combined binding screw and switch pillar shown, and the modified arrangement of same.

11391. "Improvements in the conduction, distribution, and regulation of electric currents, and in cables and other apparatus employed therein." F. WYNNE. Dated September 7. 8d. The inventor inserts sets or systems of electro-motors and generators mechanically connected to each other and sometimes made in one, into the main circuit of a dynamo or other suitable source of electrical energy, and suitably connects the conductors of a derived

circuit as a shunt to the motor. When a motor system is at work part of the current goes through the motor and part through the derived circuit, but the whole goes through the generator, and it is arranged that when much current goes through the derived circuit the generator does little work, and that when much current goes through the motor armature the generator does proportionately more work. The claims are 14 in number.

11990. "Improvements in apparatus for the transmission of electrical energy." G. J. KORNMULLER. Dated September 21. 8d. Relates to improvements in electric apparatus consisting of an electro-magnet with its armature, which latter is so arranged that it breaks the current as soon as it is attracted towards the magnet by it. The claims are 3 in number.

12097. "Improvements in electrical communicating apparatus applicable for use in navigable vessels and other purposes." W. CHADBURN. Dated September 23. 1s. 1d. Consists of an apparatus provided with manual transmitting and receiving instruments, provided with any desirable code, or system of words, letters, figures or other cyphers. The transmitting and receiving instrument are each provided with a similar code, or similar words, or ciphers, an electrical device and system of circuit wires being provided for each word, or letter, or cipher. These circuits are made and broken in the transmitting instrument, and are effected by any suitable means, such as a switch device. The receiving instrument is operated from the transmitter by a magneto, or magneto-electric motor, consisting preferably of a rotary armature and field magnets, which is provided with controlling and locking devices arranged and operating in connection with the transmitting instrument by electro-magnets in such a manner that the motor of the receiving instrument will work the indicating device or pointer up to the word, letter, or cipher which has been transmitted, and the pointer or indicating device having arrived at the proper position is then and there stopped and locked. The motor is energised in any suitable way. The claims are 9 in number.

12117. "An electric furnace." W. MAXWELL. Dated September 23. 8d. Relates to a furnace heated by electricity, arranged in such a manner that substances can be treated in it under special conditions as to the quality and pressure of the atmosphere surrounding them, and the amount and character of the heat imparted to them, while they can be kept under observation during the treatment. The claims are 6 in number.

12264. "A new or improved construction of electrical transformer." W. H. SNELL. Dated September 27. 8d. Claim:—The described construction of electrical transformer consisting of the division of the iron core into a number of separate sections upon each one of which sections a separate secondary coil is wound while the primary coil is wound over all the sections, substantially as and for the purposes set forth.

12422. "Improvements in telephonic apparatus and circuits." P. RABBIDGE. Dated September 30. 8d. The inventor places in a telephonic circuit a material of which the resistance varies according to the pressure given to it, and to apply different pressures he employs the magnetic attractions of a permanent or electro-magnet in a local circuit. The magnetic attractions are regulated by increasing or diminishing the current in the circuit which surrounds the magnet and for this purpose the circuit is completed through a telephone instrument which is capable of varying the current according to the impulses of the sound waves which it receives. The claims are 7 in number.

12491. "Improvements in electric clocks." V. RECLUS. Dated October 1. 11d. A small electrical apparatus attached to the motor mechanism, winds up automatically and continuously the barrel of the striking apparatus and that of the motor mechanism. These barrels are able to store up sufficient power to go a certain time without the help of electricity and thus allow the batteries and the wires to be changed if required, without occasioning thereby any break in the working of the system. The electrical apparatus acts at intervals which are sufficiently short to constitute practically a continuous winding up. In consequence, the springs are always under a uniform tension, and thus exert a constant force which ensures a perfect regularity in the action of the mechanism, and these springs having under these conditions only to store up an inconsiderable force of short duration, allow of the employment of barrels of very small dimensions. The connection between the motor mechanism or time measuring apparatus and the receivers or time indicators is such that the hands of these latter may be caused to move either every half minute, or every minute, or at any other interval of time. The claims are 6 in number.

12605. "Improvements in telegraphic relays." A. M. CLARK. (Communicated from abroad by C. Diener, of Vienna.) Dated October 4. 8d. Claims:—1. In a telegraphic relay, the combination with a springy or flexible armature lever which admits of the armature moving a short distance toward the poles of the electro-magnet after the local circuit has been closed, of a spring, which is put in tension by the armature whilst the latter is performing this last portion of its motion, and whereby the armature is retracted when the line circuit is broken, substantially as specified. 2. In a telegraphic relay, the combination with a springy, flexible armature lever, which admits of the armature moving a short distance towards the poles of the electro-magnet after the local circuit has been closed, of a lever so arranged as to be carried along by the armature during the last portion of its motion towards the poles, and of a spring so connected to this lever as to be put in tension by the motion of the lever when it is acted on by the armature, as and for the purpose specified. 3. In a telegraphic relay, the combination with a springy, flexible armature lever, which admits of the armature moving a short distance towards the poles of the electro-magnet after the local circuit has been closed, of a two-armed lever so arranged that one end of the same will be carried along by the armature during the last portion of its motion towards the poles, and of another two-armed lever supported by the other end of the first one, and so connected to the antagonistic spring of the armature lever that the tension of this spring will be increased by the motion transmitted to the second lever from the first when the armature acts thereon, substantially as shown and described.

12668. "The coupling of wires for fencing telegraph wires and such other purposes as it may be adapted for." W. J. P. WALKER and W. P. WALKER. Dated October 5. 8d. Consists of a plain metal tube or socket of any required length or thickness of just sufficient diameter inside to take three wires of the gauge required at a driving fit, or two wires of the guage to be coupled and one of another gauge to make a driving fit with the other two; the ends of the wires to be coupled are then passed through the tube or socket in opposite directions, the key piece as described above is then driven in flush with the ends of the tube, or as otherwise desired, and the ends of the wires to be coupled are bent over at or nearly at right angles over the ends of the key-piece, and then cut off flush with the outside diameter of the tube, or the ends of the wires to be coupled may be bent as described above before inserting through tube, only care must be taken that they be not bent too long so that they cannot be passed through the tube with one wire inserted in the before-mentioned tube. The claims are 2 in number.

12880. "Improvements in armatures of dynamo-electrical machinery and electrical motors." R. E. B. CROMPTON. Dated October 9. 8d. Claims:—In an armature for a dynamo-electric machine or motor for large currents: 1. Forming the active parts of the conductors of wires twisted together as and for the purposes described. 2. The construction of external conductors formed of two or more bars crossed in the middle of the armature, substantially as and for the purposes described. 3. Constructing each conductor so as to be divided into two or more bars, strips or wires connected at the ends and crossed so that they have equal electromotive forces induced when passing into or out of the field, as and for the purpose set forth. 4. Forming the conductors of two or more bars, strips or wires crossed at the end or ends of the armature, so that in each section the electromotive force is approximately the same in all the bars, strips or wires, as set forth.

13293. "Improvements in devices for transmitting rotatory motion from motors to dynamo-electric and other machines." S. ALLEY and A. G. BROWN. Dated October 19. 8d. Claims:—1. In devices for transmitting rotatory motion from motors to dynamo-electric and other machines, the combination of an adjustable intermediate frictional pulley, between the driving pulley of the motor and the driven pulley of the dynamo-electric or other machine, with a belt passing round the two pulleys, substantially as and for the purposes described. 2. In devices for transmitting rotatory motion from motors to dynamo-electric and other machines, a coupling connecting the shaft of the driven pulley or the driven pulley itself to the shaft of the dynamo-electric or other machine, and constructed substantially in the improved manner described.

## CORRESPONDENCE.

### The Lever Dynamo.

It was my intention to have replied ere this to your criticism on my dynamo, which you so kindly described and illustrated in your issue of the 22nd October; but I have delayed this reply in order to put you in possession of some comparisons I have made with my dynamo and with a Phœnix machine. You say that the lines of force do not appear in my machine to be utilised to the best advantage to the conductor on the armature. Now in the Phœnix machine, which I have compared with my own, the armature has a diameter of 9 inches and is 10 inches long, with 36 sections, and has 10,712 ampère-turns on the armature for an output of 2,400 watts, and the armature revolves at 1,600 per minute. My machine gives an output of 2,310 watts with an armature of 8 inches diameter, 7½ long, 36 sections, and 3,960 ampère-turns, and the armature rotates 1,550 times per minute. I do not know what the ampère-turns are on the field magnets of the Phœnix machine, but I am quite within the mark in saying that my dynamo has less than one half the quantity of wire on the field magnets. Again, the Phœnix armature has a very small surface of iron and

a large surface of wire rotating in proximity to the pole pieces. My armature has a larger surface of iron than wire, which revolves within the pole pieces and yet gives much greater results. I do not attach much importance, therefore, to your theory.

You ask, in the concluding portion of your criticism, whether I am aware that Mr. Werdermann and Mr. Mordey have used grooved pole pieces. It would, indeed, have been futile, had I laid any claim to the use of grooved pole pieces *alone*, seeing that not only Messrs. Werdermann and Mordey, but Heinrichs, Gülcher, Higgs, and others have used grooved pole pieces in conjunction with armatures of the Gramme type. The *fundamental* idea which these inventors had was to increase the surface of the wire or conductor which rotates within the pole pieces. That is not my idea at all. My idea has simply been to increase the surface of the iron of the armature and leave the conductor as it was. Practical experience has shown me that I am right in this, and that I can still effect further improvements. In conclusion, I would say that, from what I have been able to find out, Mr. Hookham, of Birmingham, is the only one who has attempted to carry the teeth of a Paccinotti or polar armature inside grooves in the pole pieces, but this gentleman is some two or three months behind me in his patent application.

**Charles Lever.**

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### Underground Wires.

Absence from London has prevented my replying sooner to your correspondent, "W.," and denying the correctness of his statements. He is quite wrong in saying that our system at Antwerp has been condemned, having failed to give satisfaction. This is not the case. The cables were in thorough order when the station was shut down in consequence of the judgment of the Belgian courts, giving the monopoly of lighting in that city to the gas company.

I am much surprised at your correspondent's ignorance of facts in view of the sweeping condemnation contained in his first letter. He could have had no knowledge as to Antwerp, and it hardly appears just to make grave charges on hearsay evidence, especially when the evidence is incorrect. The prominence given in his first letter to his "experience" contrasts strangely with his explanation in the second of having simply "learnt." We all know too well the difference between learning and experience.

Concerning America—if all the reported utterances of electrical engineers were implicitly believed, one would conclude that they are all positively hungering to go underground. From personal contact with them, I know that the last thing they desire or intend willingly to do is to bury their arc wires.

When it is borne in mind that the main point in America is to get work done quickly and cheaply, but anyhow, and the extra first cost of underground work is considered, their feeling is quite comprehensible.

The large proportion of their arc lighting is in "cities" innocent of paving. These can hardly be expected to have reached a point in advance of London in respect to the disposal of their wires.

Several satisfactory methods are in existence. It is not the system that is wanted, but the means and inclination, and because arc wires still remain strung overhead throughout the States in a way unknown here, it is not to be taken as granted that the method of otherwise disposing of them is still unattained.

In incandescent lighting it is different. The feeders are now placed underground in preference, and the choice generally lies between our cables and Edison tubes. Mr. Bright has already answered "W." as to these latter; I would only add that although far from perfect the tubes do their work. The difficulties inherent in that system have led to the extensive use of our cables, and it is only a question of time for the arc wires to follow.

With reference to work done by us in this country and elsewhere, full particulars are and always have been in the hands of the trade, and are never refused to any person having a right to obtain them, but I certainly have neither the time nor the inclination to gratify the curiosity of anyone who hides his identity under an initial.

**T. O. Callender,** *Manager.*
FOR CALLENDER'S BITUMEN TELEGRAPH AND WATERPROOF COMPANY, LIMITED.

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### Information Wanted.

Perusing your columns of the week beginning October 28th, I read with much interest of the new electric light installation at Messrs. Lloyds, Barnett and Bosanquet; but the light being derived from power of charged accumulators, although engines and dynamos are on the premises, leads me to suppose that they have found that plan cheaper than receiving the current *direct* from the machines. I should feel much obliged could you or any of your readers furnish me with some data as to costs, and comparative costs of the system.

**C. Latimer.**

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### The Phonic Wheel.

In your issue of September 30th I observe an article by M. La Cour giving an account of his investigations upon the phonic wheel; and I desire to call the attention of your readers to my own experience with a nearly identical apparatus.

In the first instrument that I constructed, a bar of soft iron revolved about an axis passing through its centre and perpendicular to its length. Twice during each revolution this bar nearly completed the magnetic circuit of an electro-magnet, which was excited intermittently with the aid of a battery and an interruptor tuning fork. Subsequently I adopted an arrangement similar to that of Froment's electro-magnetic engine, in which a number of bars are placed axially upon the circumference of a revolving drum. Like M. La Cour, I could do but little until I introduced a revolving ring filled with water. This is without effect upon a truly uniform rotation, but tends to damp the oscillations about the proper steady motion, which are otherwise very persistent.

My first successful experiments were made in 1874 or 1875—I cannot now be sure which—but so far as I can find I published nothing upon the subject until March 30th, 1878, when I exhibited my apparatus at a meeting of the Physical Society and gave a detailed statement of the theory. The following report (not written or corrected by myself) appeared in *Nature*, May 23rd, 1878:—

"Lord Rayleigh exhibited and explained an arrangement which he has employed with advantage in certain acoustical experiments, in order to secure absolute uniformity in the rate of rotation of an axle. After referring to the mathematical principles involved in such a problem, he explained that the only hope of its solution lay in the employment of a vibratory movement, which by some suitable device must be converted into a motion of rotation. The axle whose motion it is required to maintain uniform is usually driven at an approximately uniform rate by means of a small horizontal water wheel, or, in some cases, the electro-magnetic regulating apparatus presently described is sufficient by itself to supply the necessary power. At equal distances round the axle are arranged four soft iron armatures which successively come in front of the poles of a horse-shoe electro-magnet placed in the circuit of a four-cell Grove battery. The current is rendered intermittent by the following arrangement. Passing into the body of a tuning fork vibrating about 40 times per second, it leaves by a small platinum stud which is touched at each vibration of the fork; the current then traverses a second small electro-magnet between the prongs, and by this means the vibrations are maintained; passing to the magnet above referred

to the current then returns to the battery. The velocity of the axle is such that it performs about one complete revolution for every four vibrations of the fork, and the exact adjustment is effected as follows. If the driving power be just sufficient to produce the desired speed, the armatures will be so attracted by the magnet as to be exactly opposite to it at the middle of its period of magnetisation, and so long as this position is maintained the magnet will not, on the whole, affect it. But if a disturbance occur in the driving power the armature will be displaced from its former position and will be attracted by the magnet until the error is compensated. Besides the armatures this axle also carries, concentric with it, a hollow metallic ring filled with water, and as this possesses a certain momentum in virtue of its rotation, it will act as a drag tending to check the velocity in case it increases, and in a converse manner when a diminution occurs. A blackened disc perforated with rings of poles of various numbers also rotates with the axle, and by placing the eye behind the ring of *four* poles and observing a prong of the fork it is easy to ascertain whether the uniformity is maintained, since in that case the prong will appear to remain stationary."

I fully explained at the time the distinction between this apparatus, as controlling the *position* of the revolving piece, and an ordinary governor which regulates the *velocity*. An application to the determination of absolute pitch is given as an appendix to one of my papers upon the ohm (Phil. Trans., 1883, p. 295). It has sometimes appeared to me that the principle might be applied to the regulation of equatorial telescopes.

**Rayleigh.**

*October 29th*, 1887.

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### The Working of Arc Lamps.

Mr. Ross certainly hits the nail on the head when—*àpropos* of the correct working of the Thomson-Houston arc lamps—he says, "I cannot help thinking that it is not so much the lamp and the carbons as the dynamo with its constant current." I am able to endorse this, since I have lately had experience of working the same arc lamp by constant current dynamos, which I formerly worked by ordinary machines. It just makes all the difference between what I may term "mediocrity" and burning to perfection.

Arc lamps are more sensitive to speed variation at the dynamo than might be casually imagined, and herein lies one of the great gains by using automatic constant current dynamos. If you obtain a well-governed engine to drive an ordinary arc light dynamo, and if you use "continental" best quality cored and solid carbons, you may obtain arcs as steady as those driven by a constant current machine, but if you still keep your engine speed constant but use common carbons you run the risk of unsteady lights at once, variations of arc resistance, &c., due to impurities upsetting the constancy of the current. At least, this is my experience. By the use of constant current dynamos all the difficulties disappear, you may allow your engine speed to vary within reasonable limits, and you may use the cheapest carbons you can lay your hands on, and still you get a light as steady and good as that which cost you so much trouble and expense to maintain before.

Mr. Ross refers to Mr. Swinburne's letter—let me refer to it also (for certainly Mr. S. had the lion's share of the common sense appearing in the correspondence on "The Causes of Unsteadiness in Arc Lamps"). I entirely agree with his remarks even down to the admissibility of a practicable dash-pot.

My philosophy as a manufacturer is: Have a dash-pot in your lamp (which is easily taken out and emptied if the lamp is to be moved). If one's customers use one's own constant current dynamo, well and good; they will not require to use the dash-pot, they can simply leave it empty; but if they are going to graft one's lamps upon some "strange and unaccustomed" machine they may be glad of the dash-pot. And here I should like to remark that this British custom of using one man's lamp and another person's dynamo is certainly not to the advantage of electric lighting. It is not done in America, and it is high time it ceased on this side of the water.

As to Mr. Lever's remarks respecting short arcs, if I may refer to them, I cannot see that short or medium lengths of arc (nobody advocates a long arc, I should imagine!) have got much to do with lighting low machine shops; the only point I see is this, short arc systems go in for a big current, and this heats up the positive carbon for about an inch above the arc, and so makes a larger luminous centre, but this is not economical arc lighting. A great deal more may be done by the use of whitewash and other reflecting dodges.

I observe Mr. Ross greatly admires the Brush arc lamp; I presume he means the old Brush lamp, not the Brush Sellon. I am quite ready to admit that at the time it came out it was immeasurably superior to its contemporaries, but surely a lamp having three dash-pots in it (two of which, at least, must be filled) is inadmissible in 1887.

**J. G. Statter.**

*October 31st*, 1887.

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### Electric Street Cars.

I have read the report of Mr. Reckenzaun's paper read before the American Institute of Electrical Engineers and the discussion thereon with much interest, particularly that part which relates to worm-gearing, as it is a method of transmitting power between two shafts, which I have had to do with in various forms, both with the worm, the driver, and when it has been driven, and have always found that the end thrust was an item one could not afford to neglect. Mr. Mailloux called attention to this point, and Mr. Reckenzaun replied that he used several thrust collars on the shaft, which provide against but do not eliminate it, and mentions two cases where two worms, acting in opposite directions, have been used for this purpose, in which case, if the two worms do the same work, the end thrust is practically done away with. But with the disadvantage of a much larger number of parts, I should like to ask Mr. Reckenzaun if he has ever tried balancing this thrust in the motor itself? I have found that this is the most simple, and in small motors, the most satisfactory method of getting rid of this particular source of loss. In one case I found that the total loss was reduced to one-half of its previous amount by the simple expedient of transferring it from the bearings to the field magnets of the motor; this being done by shifting the position of the armature of motor longitudinally on its shaft so that it stands to one side of the usual central position between the pole pieces, it being shifted in the same direction in which it would be by the end thrust of the worm if no collars or equivalent devices were provided on the axle to prevent longitudinal motion. On the field magnets becoming active their pull tends to draw the armature back to its ordinary position, and a point can be found in a suitably-constructed motor at which this pull will balance the contrary action of the worm, and the armature will float, as it were, shifting its position slightly as the work to be done alters. With the further advantage that with worn or inaccurate gearing slight inequalities do not produce quite the same degree of grinding and loss that results with a ridged abutment for the worm shaft. Of course stops of some kind would have to be provided in the case of motors for tramcars, to come into action when running down hill or with the field magnets out of action, and these probably could be reduced to mere centres at shaft ends, as they would have little to do. I should like to hear if Mr. Reckenzaun has tried anything of the kind, and am sure that his opinion and experience would be of interest to many besides myself, as few have his opportunities or perseverance.

**Gerald Percival**, *Electrician.*

Cork, *October 31st*, 1887.